APRIL
1953

MECHANICAL ENGINEERING

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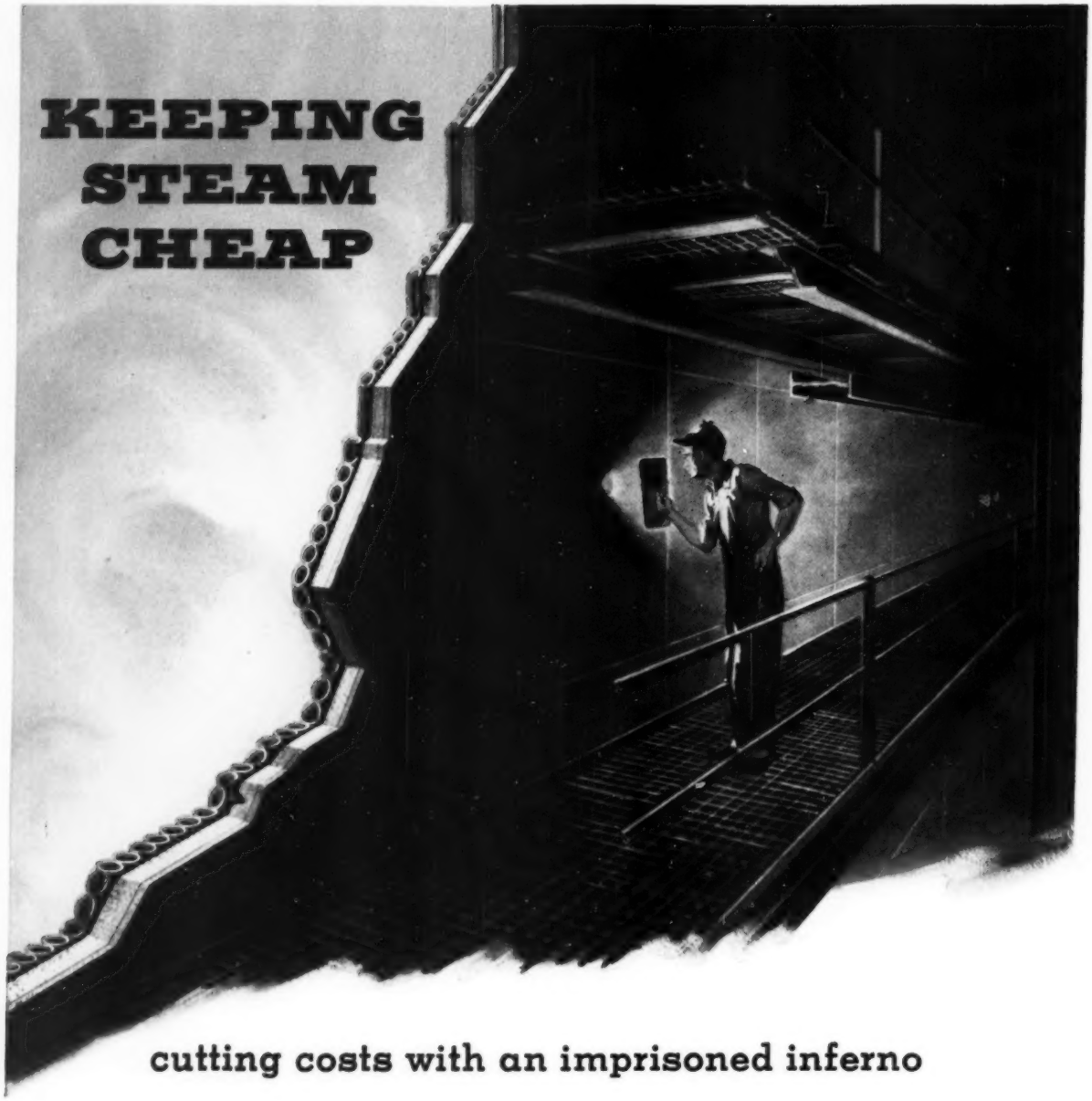
KEEPING STEAM CHEAP



cutting costs with an imprisoned inferno

When giant, coal-hungry boilers are fed as much as 50 to 100 tons of coal per hour, B&W's fuel savings through use of pressurized furnaces finds major importance in *keeping steam cheap.*

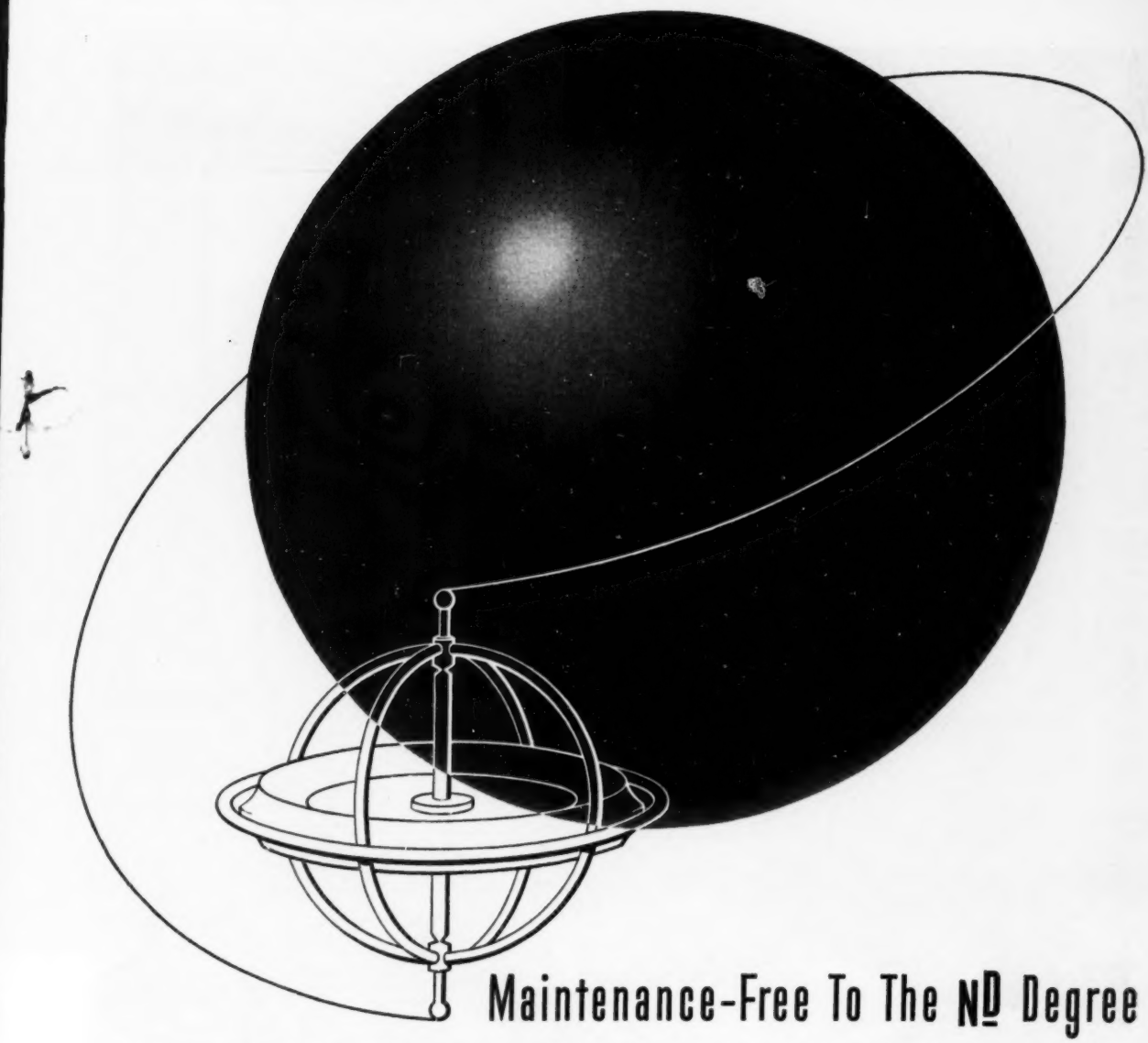
Power engineers had known for years that worthwhile savings in construction, operation and maintenance costs could be achieved if they found a good way to make boiler furnaces tight enough to operate under pressure. But with modern furnaces 10 to 15 stories high, containing a raging inferno of gases with temperatures up to 3600 degrees, the solution was not easy to find. Intensive engineering investigation plus a thorough knowledge of operating problems and conditions was needed before a successful pressurized furnace could be built. B&W engineers have licked this problem and today pressure fired boilers are serving in many of the country's greatest power stations. Already, 24 units are in successful operation—the first of them with over five years experience—and an additional 68 to serve over 7,000,000 kw of generating capacity are on order.

Pressure-firing often is used in combination with other major advances in modern steam generation resulting from B&W's Research and Development program. These include high pressures and temperatures, divided furnaces, cyclone steam separator, and Cyclone Furnace firing.

BABCOCK & WILCOX

BOILER DIVISION

N-151



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Maintenance costs can slash deeply into profits in every manufacturing plant. One way to attack this problem is to insist on New Departure ball bearings in both production machinery and end products . . . for New Departures are capable of reducing maintenance just as surely as they reduce friction between moving parts.

Often, New Departure bearings are self-sealed and lubricated-for-life so as to eliminate *all* bearing maintenance for years. This permits machines and motors to be placed in almost inaccessible locations without servicing problems.

With the need for adjustment and lubrication eliminated, New Departure ball bearings help cut costs all along the line. Keep your eye on the BALL to be sure of your BEARINGS!

This booklet illustrates many types of mechanisms which are improved by the use of New Departure "Lubricated-for-Life" ball bearings. Send for your free copy today.

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MECHANICAL ENGINEERING, April, 1953, Vol. 75, No. 4. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

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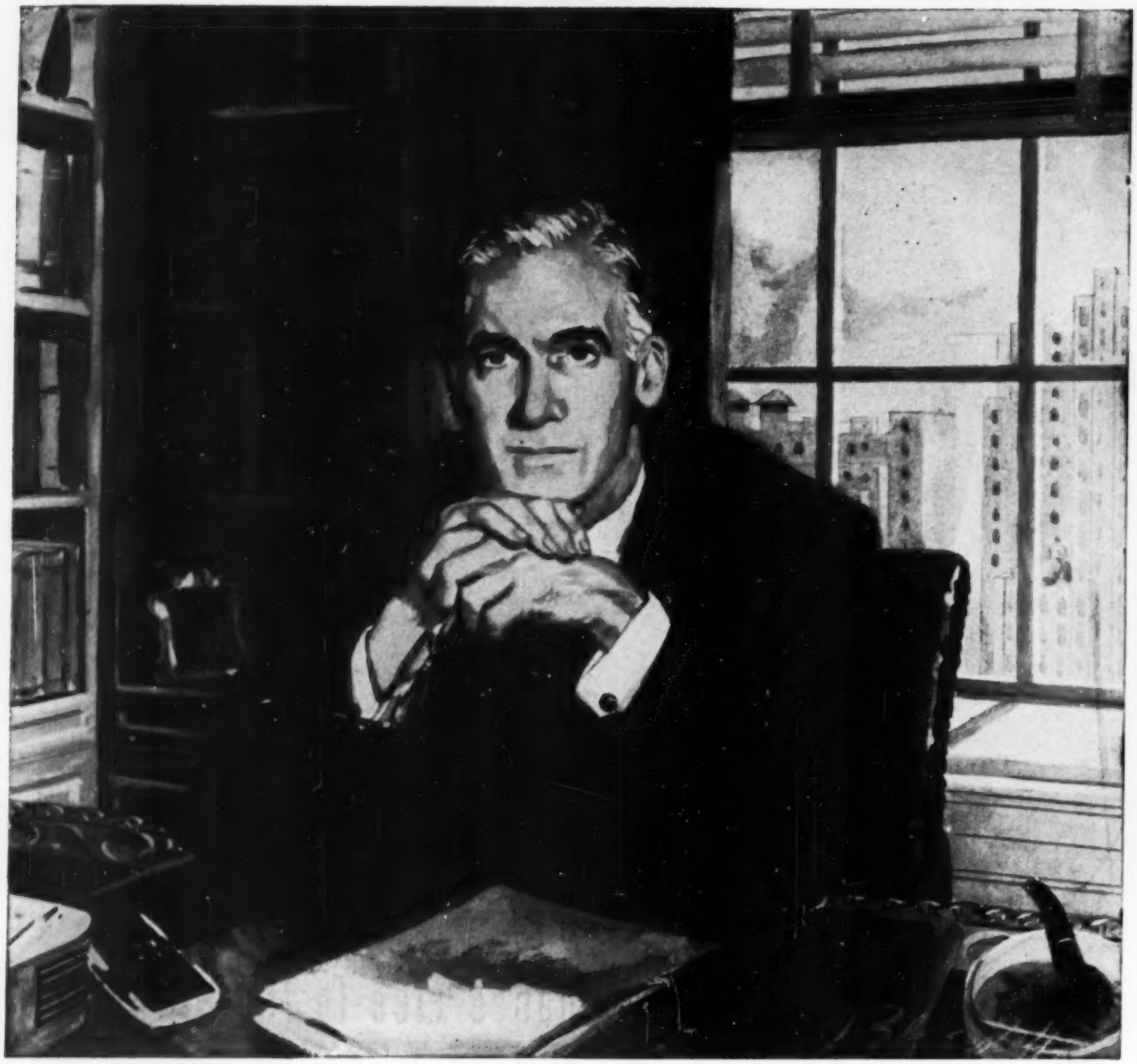

plenty of reason to set you dreaming

This is a time for planning, by business men of vision. The day must come when allocations and priorities will be words of the past . . . when materials will be much easier to get and orders perhaps much harder. Against that day, let some of your dreaming center on stainless steel, the most uniquely useful metal in the book—hard, strong, beautiful, everlasting.

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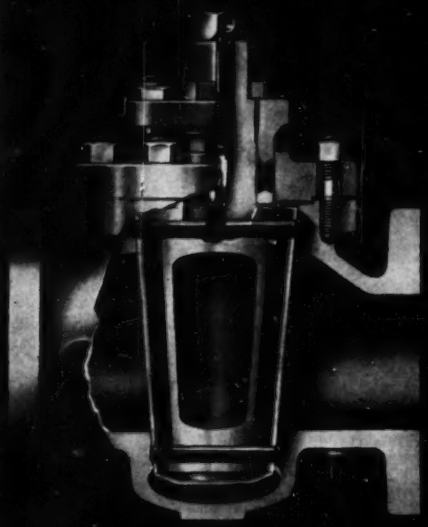


LUBRICATED PLUG

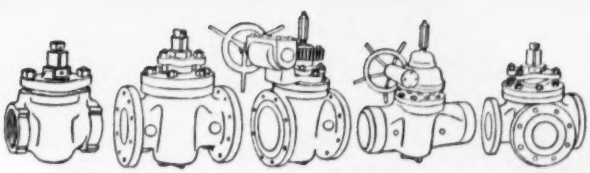
COMPLETE LINES OF LUBRICATED PLUG VALVES

Because of the wide range of services to which Lubricated Plug Valves can be adapted, they may be classed as "all-purpose" valves. Walworth manufactures complete lines of Lubricated Plug Valves in a variety of types and materials for working pressures up to 5,000 psi and for vacuum services. Sizes range from ½ to 30 inches. Write for descriptive literature.

Walworth also manufactures complete lines of gate, globe, angle, and check valves made of steel, bronze, iron, and special alloys.

Walworth valves, pipe fittings, and pipe wrenches total approximately 50,000 items and are sold through distributors all over the world.

Walworth engineers will be glad to help you with your problems. Call your local Walworth distributor, nearest Walworth sales office, or write to our General Offices, 60 East 42nd Street, New York 17, New York.



Illustrated in section is a Walworth No. 1700F Regular Gland Type, Wrench Operated, Steeliron, Lubricated Plug Valve. This particular line of valves has a working pressure rating of 200 psi at 150F or 125 psi at 450F. Sizes range from ½ to 8 inches. Other Walworth Lubricated Plug Valves include Single Gland and Ball Bearing types. They are available for a variety of working pressures.

For best results use Walworth Lubricants and Walworth High Pressure Lubricant Guns.

U·S·S CARILLOY Steel in rolled sections . . . . . .

LANDING FLAPS on the Model 340 Convair airliner slide on tracks made of CARILLOY 4140 steel T-sections. These tracks are much stronger than those formerly made from rectangular bars. And they cost 75% less!

lops 4 hours off machining time,

provides stronger flap tracks for Convair airliners

and cuts costs 75%

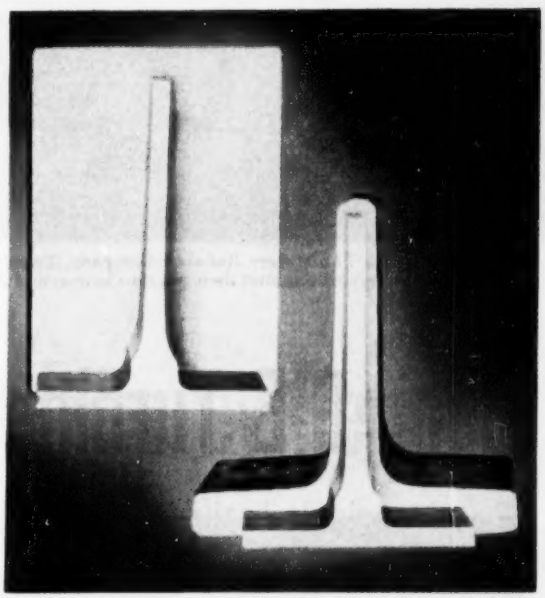
● Wing flap supports for Consolidated Vultee's Model 340 Convair airliners are stronger, cost *less*, and are of better quality now that they are made from hot-rolled sections of U·S·S CARILLOY steel.

When J. C. Peacock Co., of Los Angeles, California, started making these T-shaped flap tracks for Convair, the accepted practice was to machine them from $2\frac{1}{4}$" x $3\frac{1}{4}$" bars of alloy steel. But machining took a lot of time, and more than 50% of the stock metal was wasted in scrap.

Peacock and Convair engineers studied the problem and soon realized that they could shorten machining time and reduce scrap losses by fabricating directly from rolled sections. The question was, where to find a good supply of steel that would meet all the exacting quality requirements? Our Columbia-Geneva Division came through for them, by providing hot-rolled T-sections of CARILLOY 4140 steel.

This steel is giving excellent results. Not only are the CARILLOY parts *stronger* than those formerly used, but they require 4 hours less machining time, and reduce scrap losses 60%. What's more, finished tracks now cost only *one-fourth* as much as they did before.

Our experienced steel engineers and metallurgists may be able to help you make similar savings on *your* products. Call our nearest District Office. Chances are we can supply just the steel and the form you need.



LEFT, the T-shaped cross-section of a flap track in front of a $2\frac{1}{4}$" x $3\frac{1}{4}$" steel bar shows how much metal was formerly wasted.

RIGHT, the same flap track in front of the CARILLOY T-section that cuts scrap loss 60%.

UNITED STATES STEEL CORPORATION, PITTSBURGH • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
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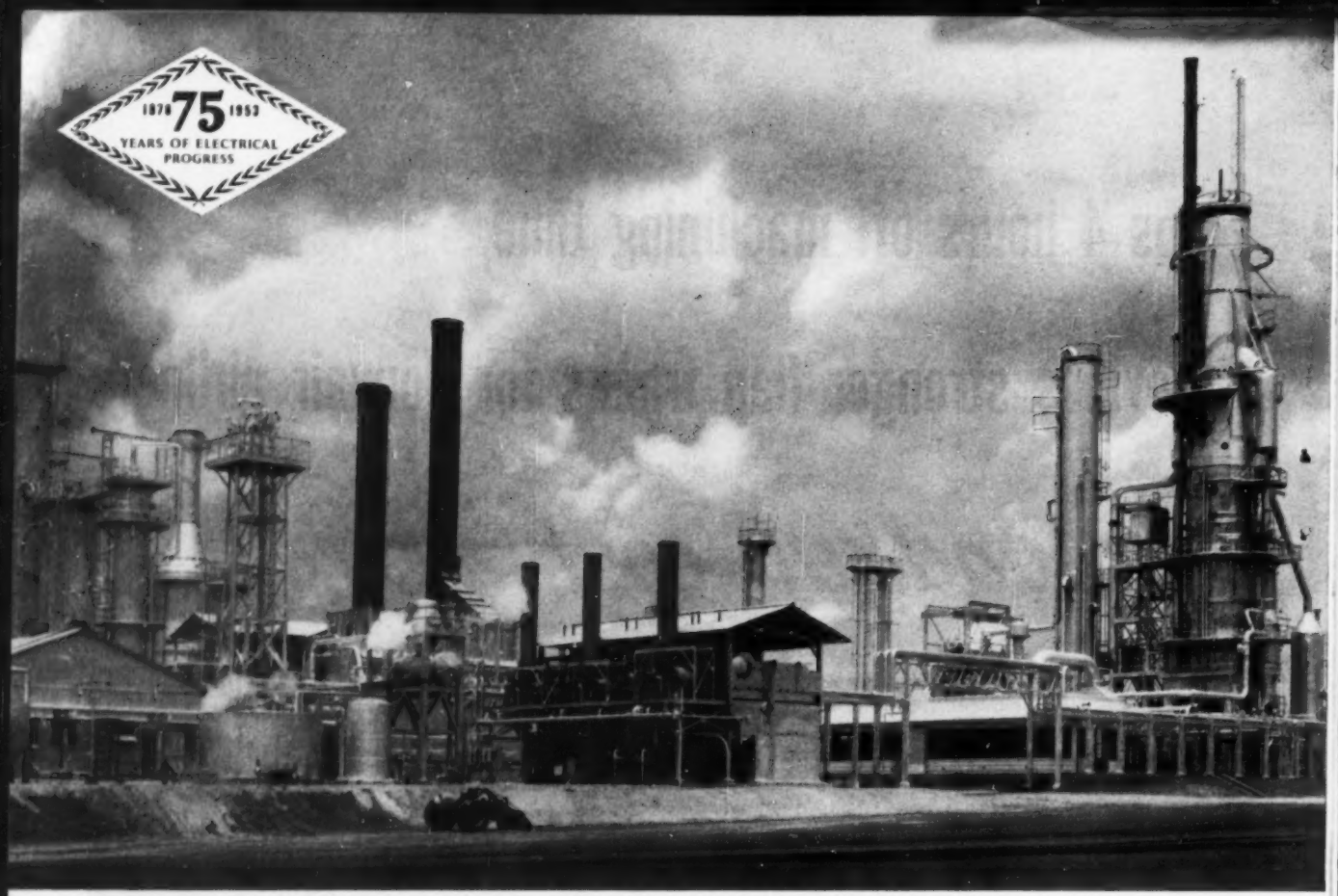
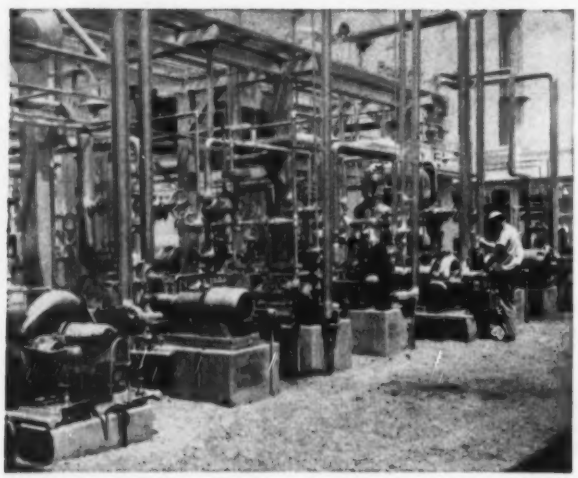
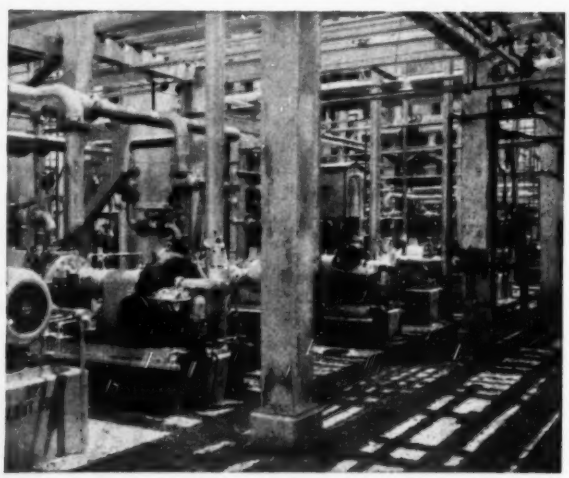


McMurrey Refining Company, Tyler, Texas, installed G-E mechanical-drive turbines throughout their plant to help assure continuous capacity output of 5000 bbls. per day.

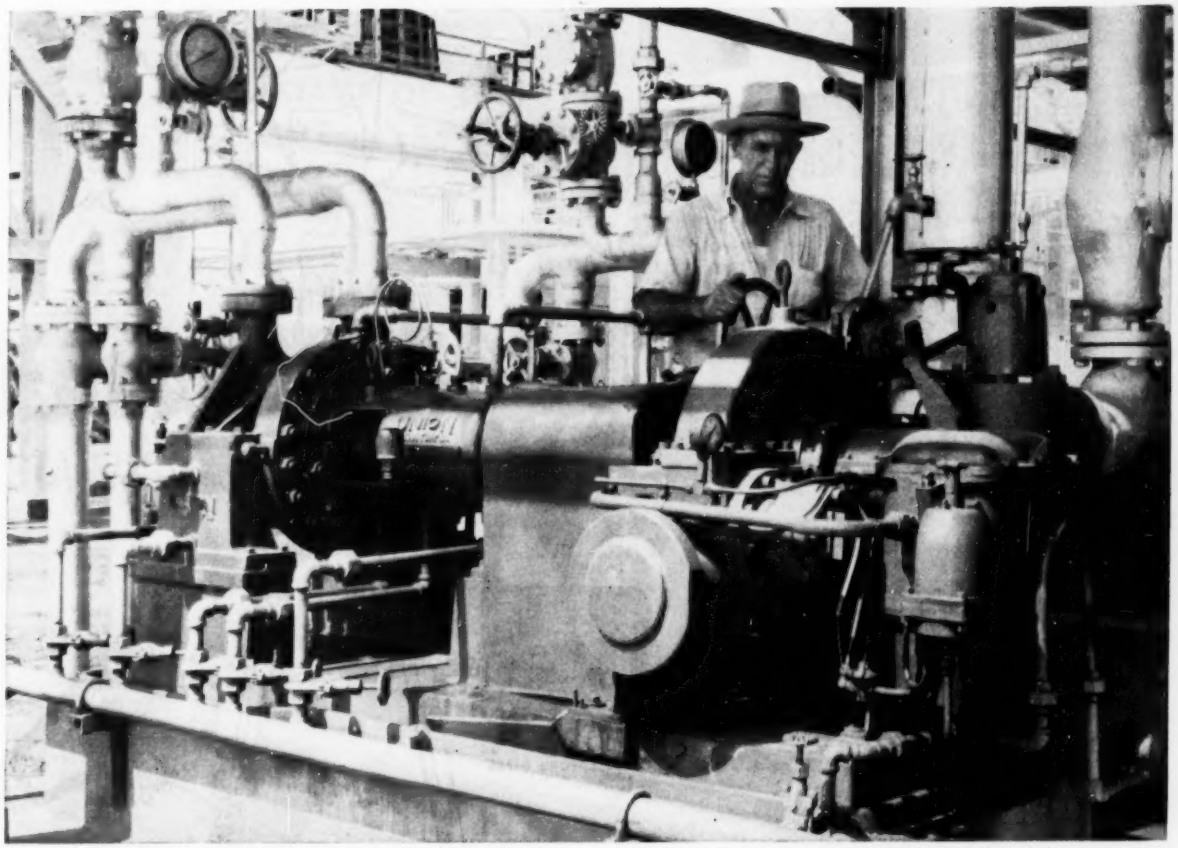
G-E Turbines Save Maintenance,



G-E turbines and motors are paired at McMurrey Refinery to utilize large steam supply efficiently. When process steam demands decrease, surplus steam is economically diverted to turbine drives. These Type DP turbines range from 8 hp to 41 hp.



Shown here is part of a row of ten General Electric Type DP turbine drives and motors, ranging from 9 hp to 48 hp. The many interchangeable parts on these turbines make stocking of spare parts an economical matter.



Maintenance personnel at the refinery have found this General Electric Type DP mechanical-drive turbine, like the many others at the refinery, easy to maintain. This 47-hp turbine at McMurrey Refinery drives a boiler-feed water pump.

Inventory Costs at McMurrey Refinery

Installed to improve steam balance, G-E standard turbines, with many interchangeable parts, also cut inventory costs.

The McMurrey Refinery, Tyler, Texas, installed General Electric mechanical-drive turbines to help regulate steam balance. Since process steam demands range from 30% to 70% of available supply, surplus steam is economically diverted to turbine drives.

Time soon proved that General Electric turbine drives have many other advantages. Mr. Dave Hood, Mechanical Maintenance Foreman at the refinery, states, "With these turbines on the line now for over a year, we're happy to report that they are extremely easy and economical to maintain, requiring very little of our time for maintenance."

Mr. Hood also said, "Since we have quite a few different sizes and ratings of turbines here, we're particularly pleased with the great number of interchangeable parts on these turbines. It certainly cuts down our inventory problem." Interchangeability of a great majority of the replaceable parts (regardless of hp rating) is a big feature with G-E standard turbine drives, which are paired with motors throughout the refinery to help assure uninterrupted service.

Call in your G-E sales-engineer or write for bulletin GEA-4955A, "A New Standard in Mechanical-drive Turbines." Section 252-59, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

Design Around

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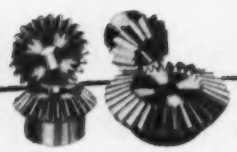
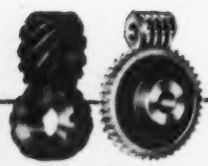
CHANGE GEARS

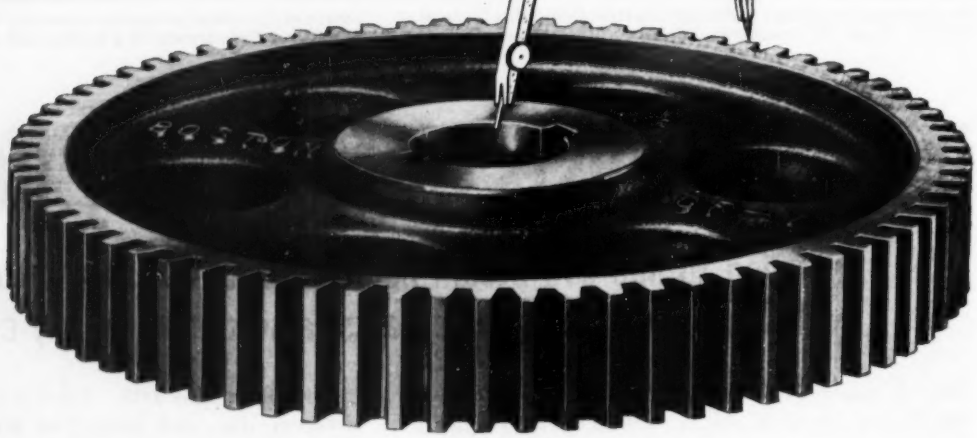


MITRES — BEVEL GEARS



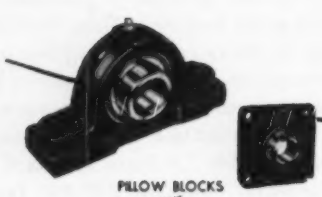
HELICALS
WORMS and WORM GEARS

CHAIN and
SPROCKET



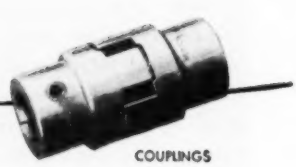
BOSTON GEAR CATALOG

Lists all gears and other BOSTON Products. Contains time-saving information on gear selection and useful reference data. Ask your Boston Gear Distributor . . . . or write: Boston Gear Works, 66 Hayward Street, Quincy 71, Mass.



PILLOW BLOCKS
and
FLANGED CARTRIDGES

UNIVERSAL JOINTS



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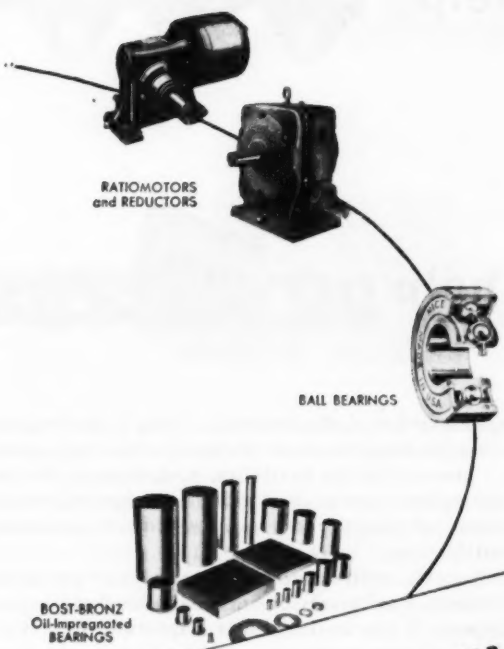

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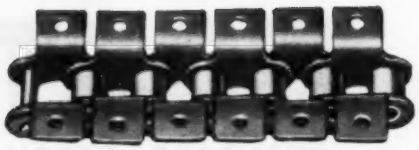
HELP

help ...help 

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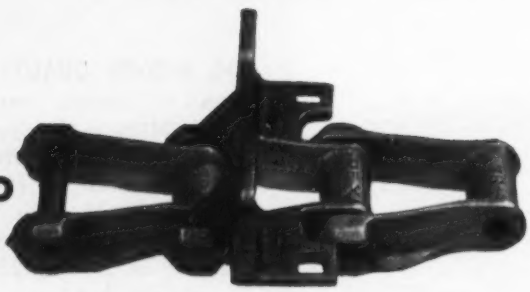
help  ...help

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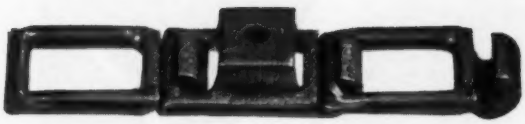

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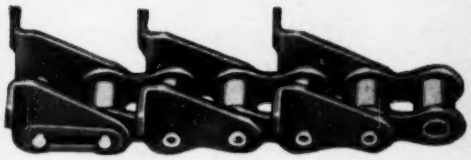

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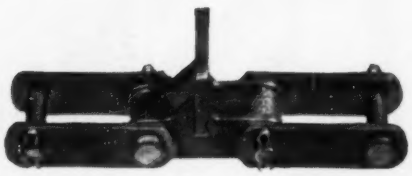

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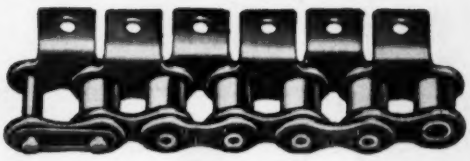

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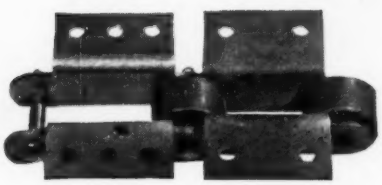

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...help

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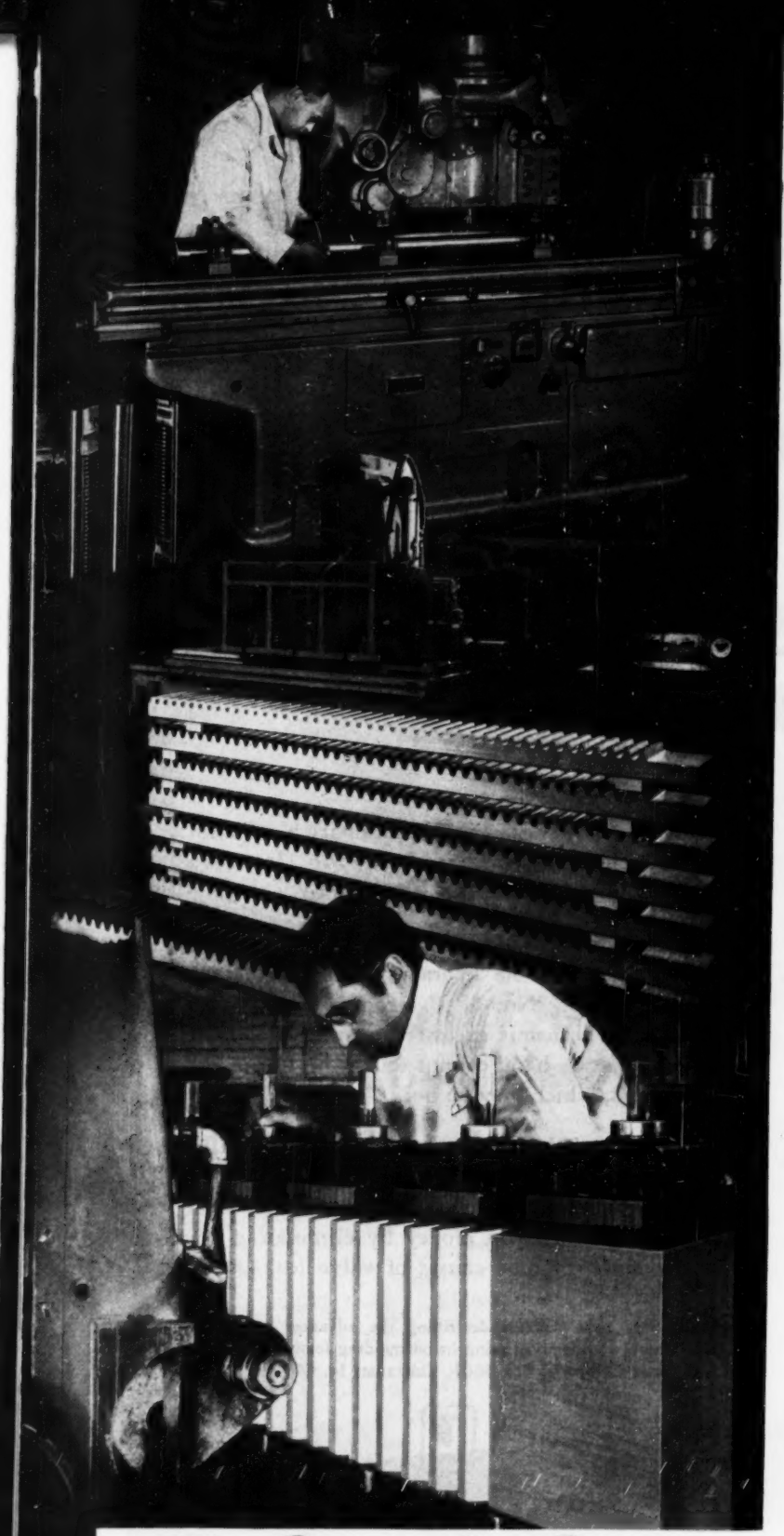

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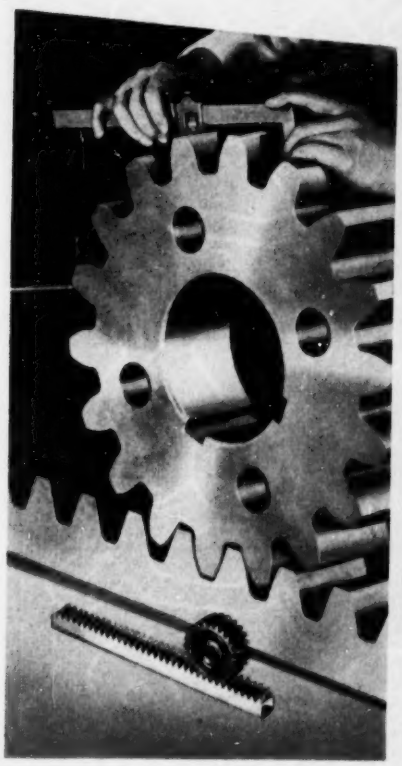

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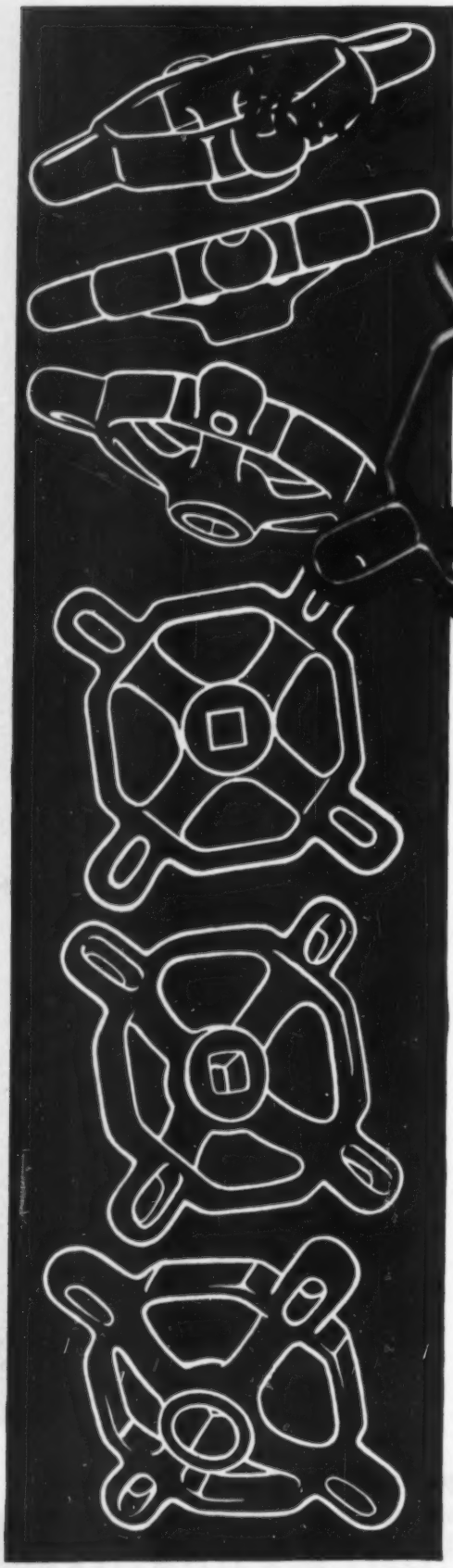

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With this revolutionary new handwheel design, *ordinary hand pressure closes the valve absolutely tight, thus preventing leakage.*

Rounded lugs provide a firm, comfortable, secure grip, even when the operator's hand is wet or greasy. And the "Non-Slip" Handwheel stays cool —does not transmit excessive heat to the outer rim. Operator's hand cannot touch the top of the valve stem, which may be hot.

Only Lunkenheimer Valves have the new malleable iron "Non-Slip" Handwheel. Ask for a demonstration of its amazing performance. Hear how it will save you money by eliminating one of the most common causes of valve leakage.

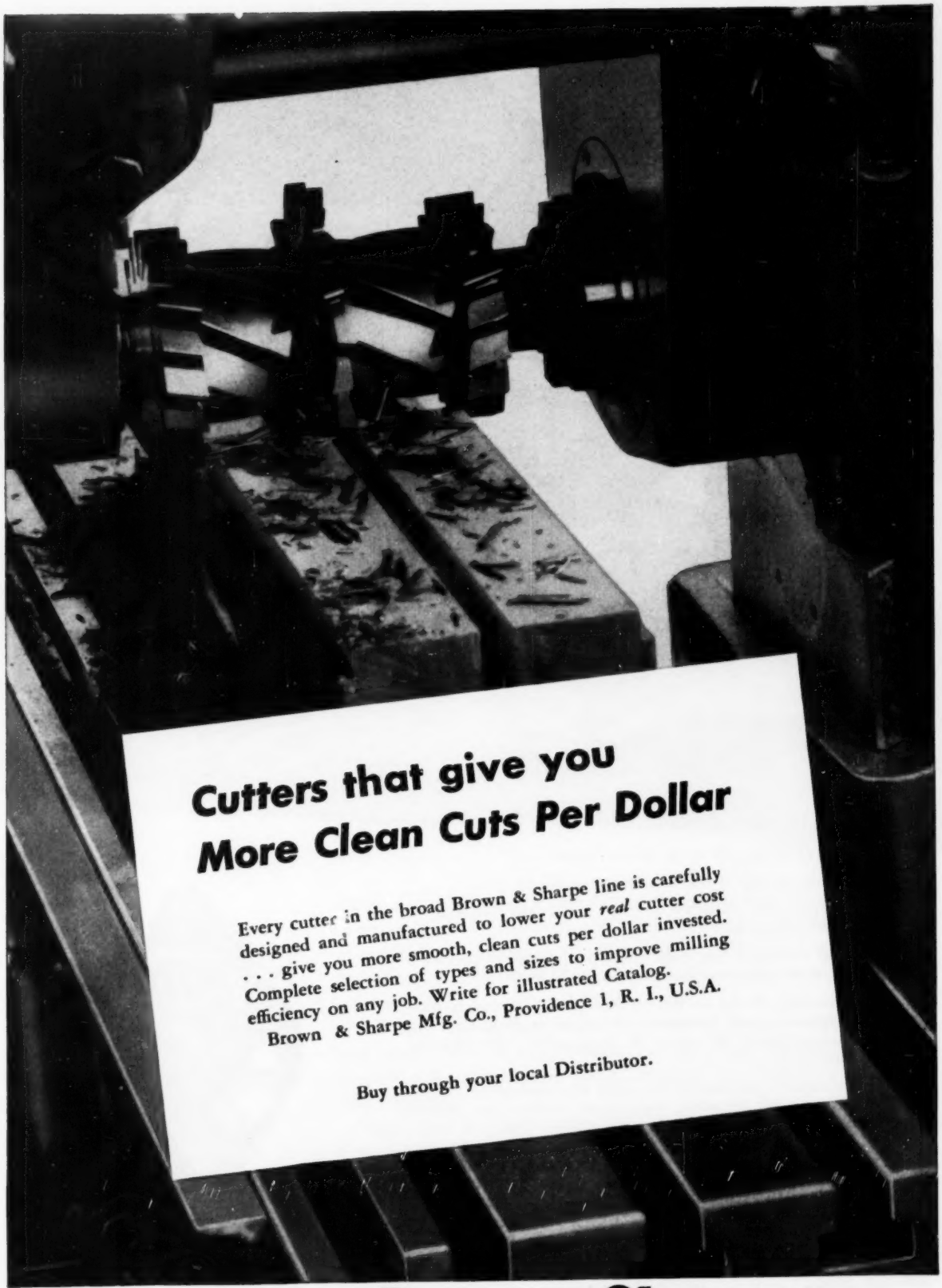
WRITE FOR new bulletin describing the advanced "Non-Slip" Handwheel and demonstrating its outstanding features. The Lunkenheimer Company, Box 360E, Cincinnati 14, Ohio.

BRONZE • IRON • STEEL

LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

L-752-5


Cutters that give you
More Clean Cuts Per Dollar
Every cutter in the broad Brown & Sharpe line is carefully designed and manufactured to lower your *real* cutter cost . . . give you more smooth, clean cuts per dollar invested. Complete selection of types and sizes to improve milling efficiency on any job. Write for illustrated Catalog.
Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.
Buy through your local Distributor.
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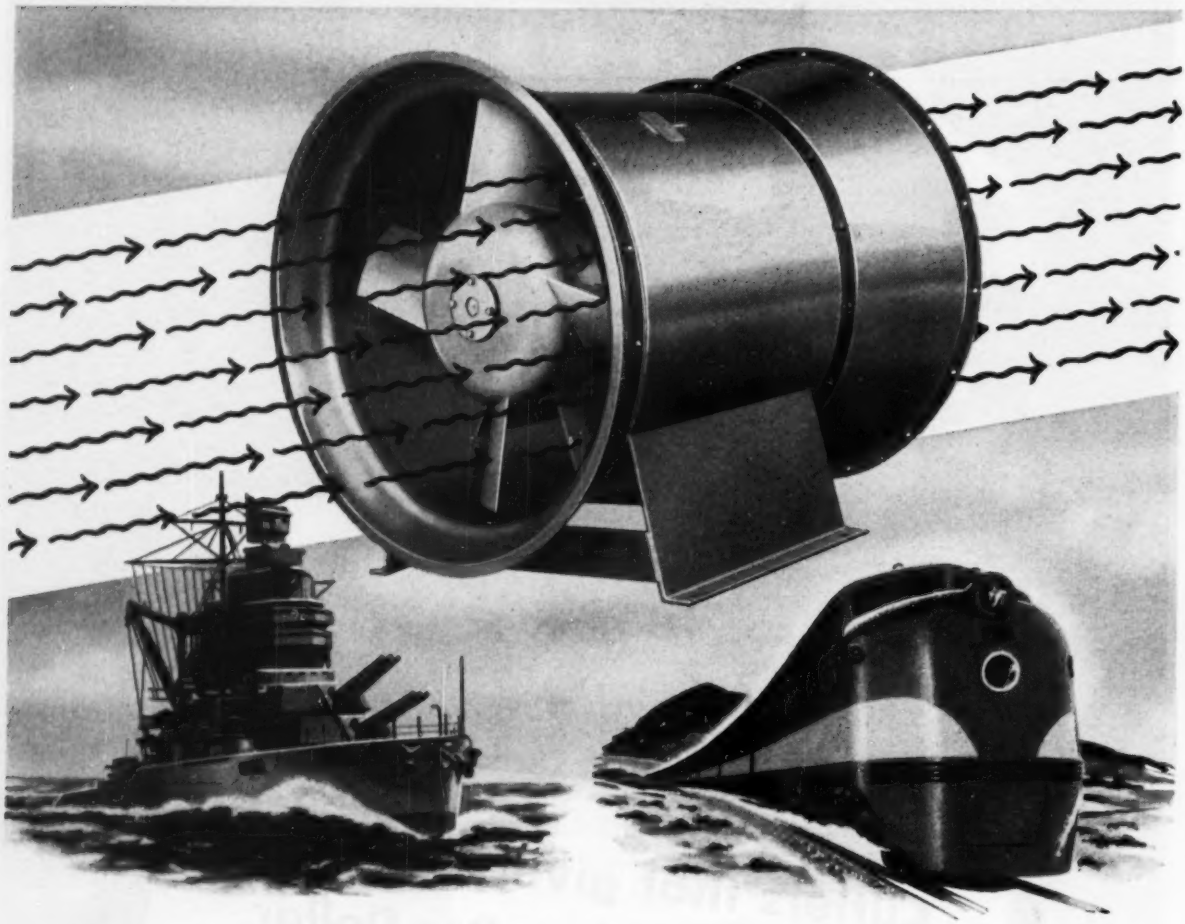
Save with American Blower Axial Fans



Dependable, low cost ventilation!

The Navy demands it on battlewagons . . .

Railroads specify it for modern streamlined trains . . .

Commerce and industry require it for the conduct of profitable business . . .

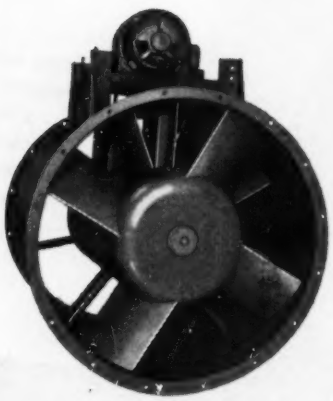
No one company has done more to provide dependable low cost ventilation than American Blower.

For example, American Blower Axial Fans are widely used in thousands upon thousands of varied applications, and are unsurpassed for ease of installation and efficient performance.

For complete information on axial fans and other American Blower Air Handling equipment, contact our nearest branch office.

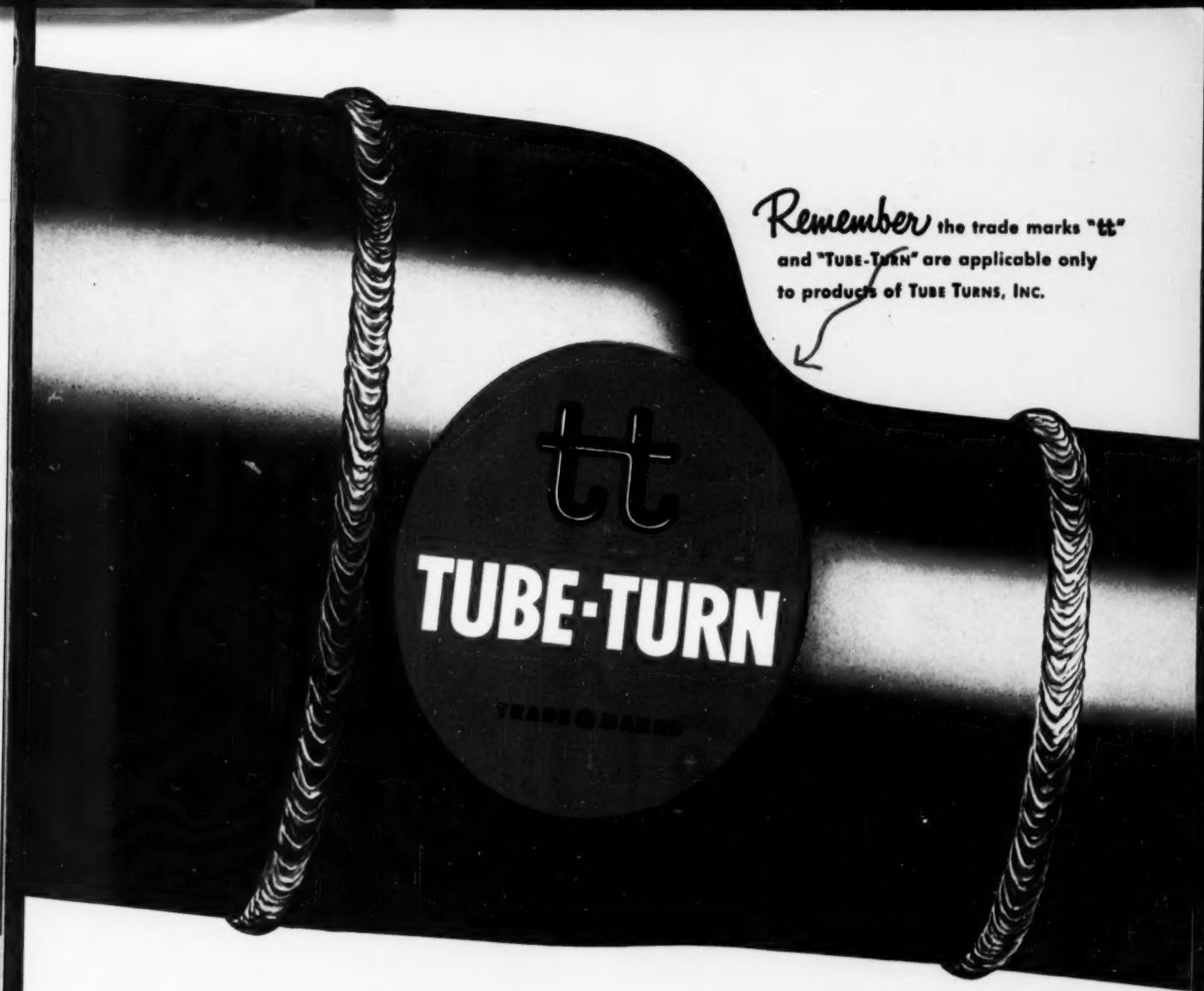
AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER
YOUR BEST BUY IN AIR HANDLING EQUIPMENT



American Blower Axial Fans are smooth in performance, built for endurance and convenient to install.

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS



Remember the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.

Engineered FOR SMOOTH FLOW

TUBE-TURN Eccentric Reducers are designed with strong knuckle contours and as gentle transitions from large to small diameters as possible. In addition to providing smooth inner walls at the joints, these features hold turbulence and pressure loss to a minimum.

Efficient piping flow reduces pumping power requirements, and investment in equipment. For efficient, leakproof piping, specify welded systems—using TUBE-TURN Welding Fittings and Flanges.

You'll find a TUBE TURNS' Distributor in every principal city. Call him for good service in good connections.

Be sure you see the double "tt"

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Houston • Tulsa • San Francisco • Los Angeles

Subsidiaries: TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO

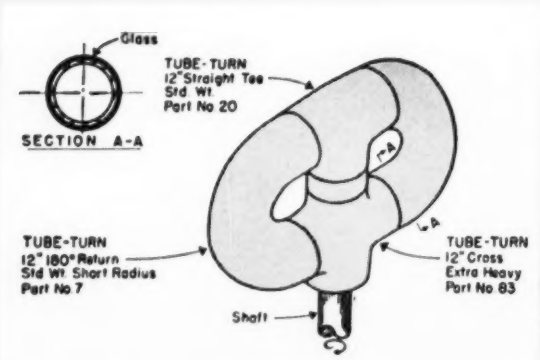
PENNSYLVANIA FORGE CORPORATION, PHILADELPHIA, PA. • KEROTEST MANUFACTURING COMPANY, PITTSBURGH, PA.

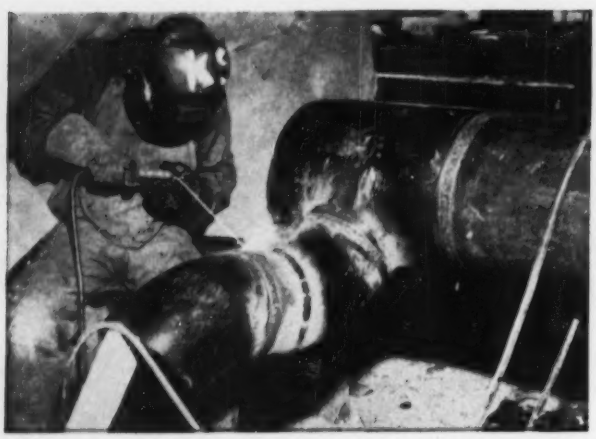
ENGINEERING SERVICE

TUBE TURNS' *Engineering Service*
HELPS SOLVE A VIBRATION PROBLEM

TUBULAR CONSTRUCTION often solves tough machine design problems and here, as in piping problems, Tube Turns' Engineering Service is ready to help you! For example:

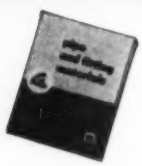
Vibration was cracking the glass coating of a plate type agitator for a brine tank in a chemical plant. After repeated replacements, the engineers decided to switch to tubular construction and called in Tube Turns' Engineering Service for design assistance. The resultant design, shown in the sketch, embodies great rigidity and is not affected by the vibration. The expensive maintenance caused by cracking of the agitator's glass coating was eliminated.





FABRICATION IS FAST. Field or shop fabrication of piping assemblies is easier when welders can count on the dimensional accuracy of TUBE-TURN Welding Fittings. True circularity and uniform wall thickness assure perfect lineup and fit.

AT GENERAL ELECTRIC. Two 16-inch steam mains, at boiler plant of the new G-E Appliance Park in Louisville, will help distribute 900,000 pounds of steam per hour efficiently. Welded piping, using TUBE-TURN Welding Fittings and Flanges, was specified for all critical lines in the new plant: high and low pressure steam, gas, domestic and mill water, and compressed air.



TUBE TURNS, INC., Dept. F-4
224 East Broadway • Louisville 1, Kentucky

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Position .....

Company .....

Nature of business .....

Address .....

City ..... *State* .....

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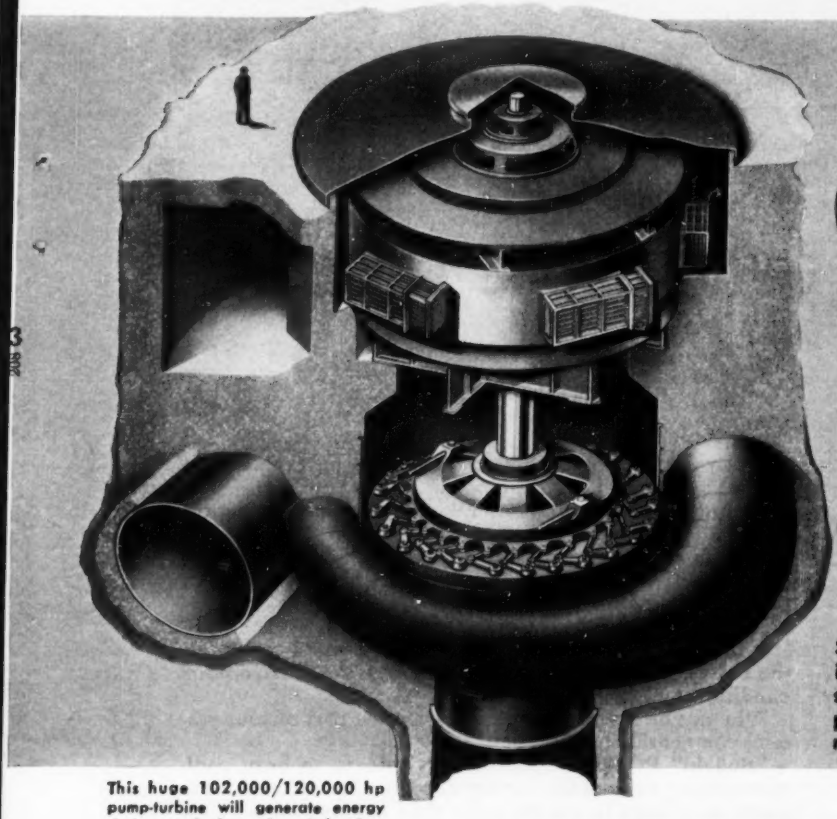
Chicago	Los Angeles

"TT" and "TUBE-TURN" Reg. U. S. Pat. Off.

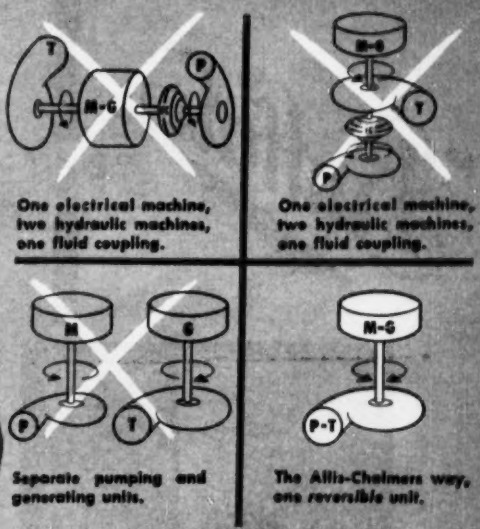
TUBE TURNS, INC.
LOUISVILLE 1, KENTUCKY

ALLIS-CHALMERS Pioneers *REVERSIBLE* Pump-Turbines!



This huge 102,000/120,000 hp pump-turbine will generate energy during peak demand periods, then reverse and — using surplus power from other plants — restore water to the reservoir during off-peak periods. Power value differential will make operation economical.

HOW REVERSIBLE PUMP-TURBINE REDUCES EQUIPMENT NEED



Sketches above show different methods of applying motive and generating equipment for pumped storage. Note that the Allis-Chalmers reversible pump-turbine at lower right requires least equipment and simplest power plant construction.

NOW BUILDING 5 UNITS FOR PUMPED STORAGE

THIS RECORD SIZE pump-turbine is now under construction by Allis-Chalmers for the Hiwassee dam in North Carolina. It combines in one reversible, two-element unit an electrical machine rated 102,000 hp as the world's largest motor and a hydraulic machine with the world's largest Francis runner.

When operating at maximum head as a turbine, this reversible unit will develop 120,000 hp. As a pump, it will move a maximum of 5200 cfs, 3.3 billion gallons per day . . . three times the capacity of the largest existing pump.

Allis-Chalmers — builder of over 12 millions of installed hydraulic horsepower — pioneered the development of the reversible pump-turbine for pumped storage. A-C offers you undivided responsibility, being able to design and build *all* elements of an entire reversible pump-turbine unit.

Of the five reversible pump-turbines A-C is now building, the Hiwassee unit is the largest. First scheduled for service is the 12,650 hp unit for the Flatiron Power & Pumping plant in Colorado. Three 19,000 hp units for the Sao Paulo Light & Power Co., Ltd., Brazil are now being built at Canadian Allis-Chalmers, Ltd., Montreal.

You get the real design advances *first* from Allis-Chalmers. And dealing with A-C is convenient, too, with 95 sales offices and 65 distributors located in 53 countries. For your free copies of Reversible Pump-Turbine Bulletin 01R7784 and illustrated, 56-page Bulletin 02B7301 of world famous hydro plants, just call your nearest A-C distributor or write to Allis-Chalmers, Milwaukee 1, Wisconsin, U.S.A. A-4011

ALLIS-CHALMERS

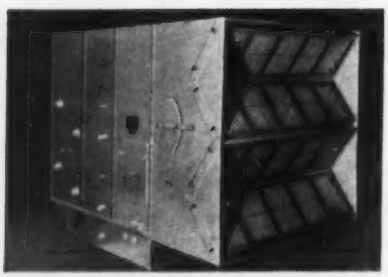
A-C ALLIS-CHALMERS

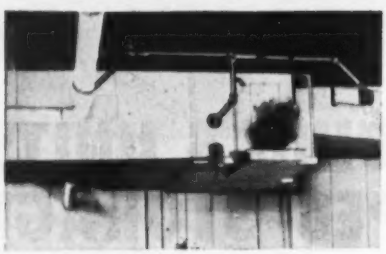
Builders of the World's Widest Range of Public Works Equipment

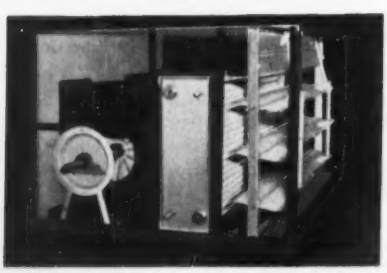
easy to install

easy to live with

"Buffalo" "PC" CONDITIONING CABINETS







When you air condition, you want three things—as inexpensive a job as will do, equipment that installs economically—and most important—equipment that gives satisfaction over a long period.

Cost-wise, the central cabinet is the least expensive part of your system; considering compressor, duct-work and building modifications.

Satisfaction-wise, its the most important!

If the fans are over rated, or inefficient, you'll suffer. If the coils are inefficient or untrustworthy, you'll have poor conditioning.

Why not be sure that on this lowest-cost part of your system, you get the best?

"Buffalo" PC Air Conditioning Cabinets, to heat, cool, humidify or dehumidify, or any combination of these functions, have been in use for more than twenty years. They are sectionalized, to pass thru standard building openings, and assemble easily on location. They have husky, quiet, mixed flow fans mounted on large, vibrationless hollow shafts. They have Aerofin coils, by far the best obtainable. They have sturdy, outside-the-housing bearings, for convenient lubrication even after cabinet insulation. In short they are built according to the "Q" Factor* which makes them your best buy!

"Buffalo" Engineering Sales Representatives in principal cities are anxious to serve you. Let them give you full details—no obligation.

*—*The "Q" Factor—The built-in Quality which provides trouble-free satisfaction and long life.*

"Buffalo" FIRST FOR FANS

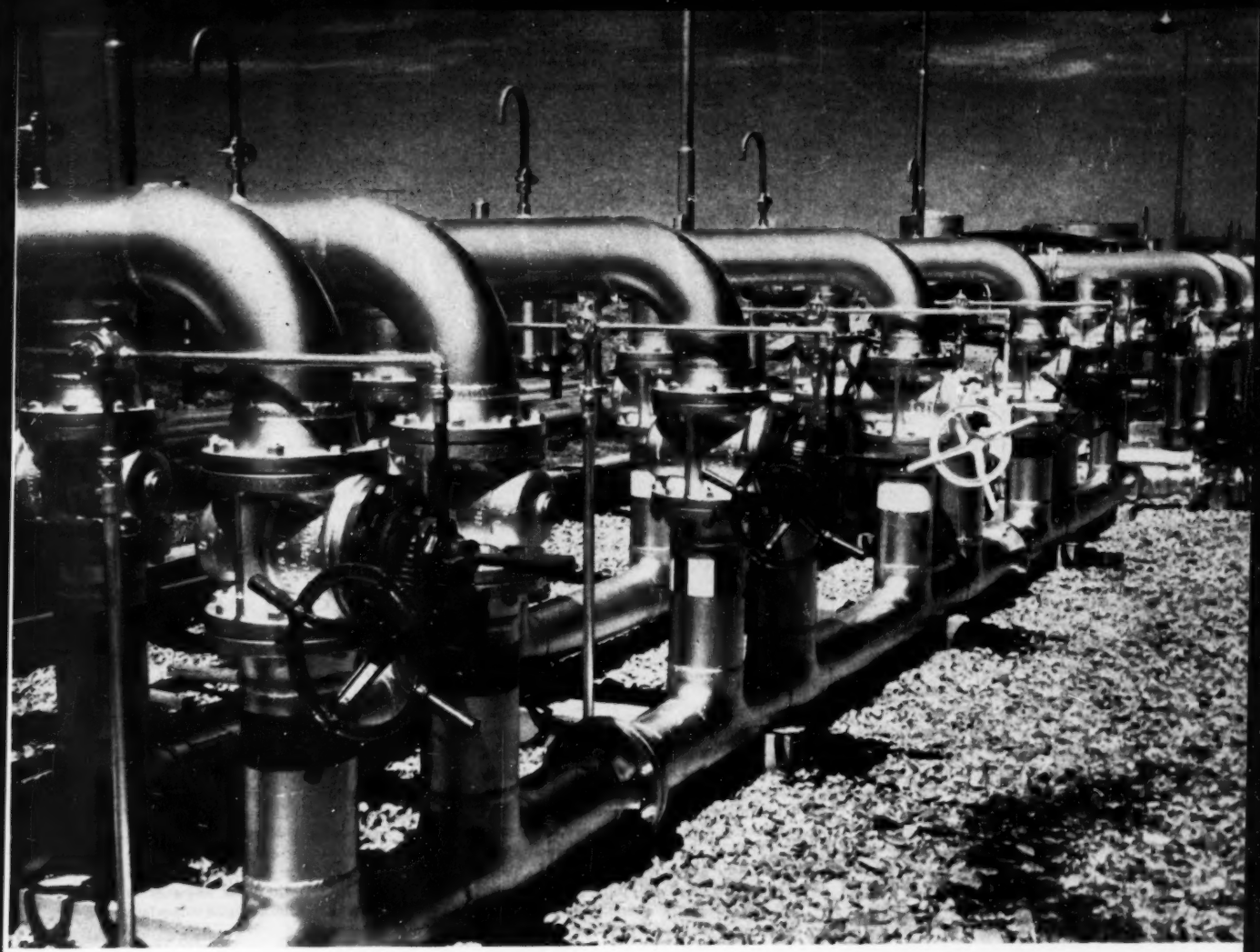
BUFFALO FORGE COMPANY

148 MORTIMER ST. BUFFALO, NEW YORK

PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities

VENTILATING | PRESSURE BLOWING | AIR CLEANING | COOLING | AIR TEMPERING | HEATING | INDUCED DRAFT | FORCED DRAFT | EXHAUSTING



In Every NORDSTROM VALVE—*the Extra Benefits of Internal Lubrication*

Nordstrom valves are made in a wide assortment of styles and metals—each especially designed to handle certain fluids at specific temperatures and pressures.

But there are a number of features common to all Nordstrom valves—a seal of lubricant that prevents leakage and protects the vital seating surfaces from abrasion . . . a quick quarter turn to open or close . . . positive rotary action that maintains an intimate contact between working surfaces . . . no pockets or cavities to catch sediment . . . genuine Rockwell lubricants.

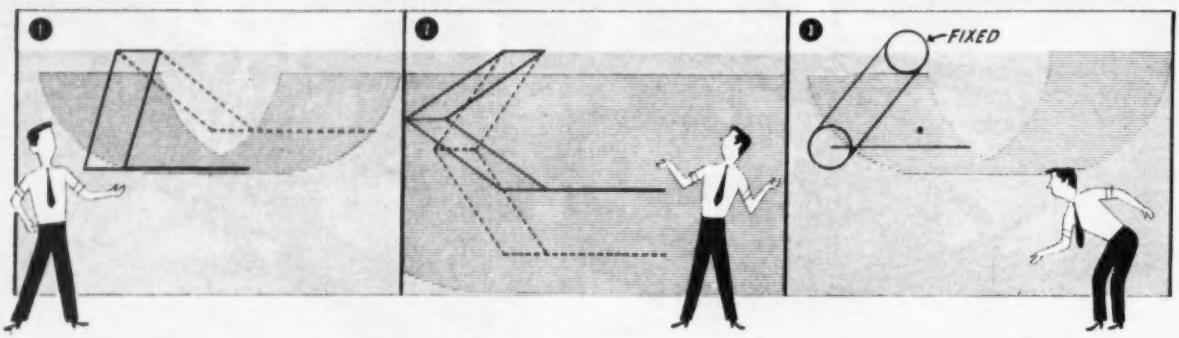
These features, embodied in every Nordstrom valve regardless of the function for which it was designed, are your guarantee of efficient control on any petroleum service. Rockwell Manufacturing Company, Pittsburgh 8, Pennsylvania.

ROCKWELL Built

Nordstrom Valves

Another ROCKWELL product

Lubricant-Sealed for Positive Shut-Off



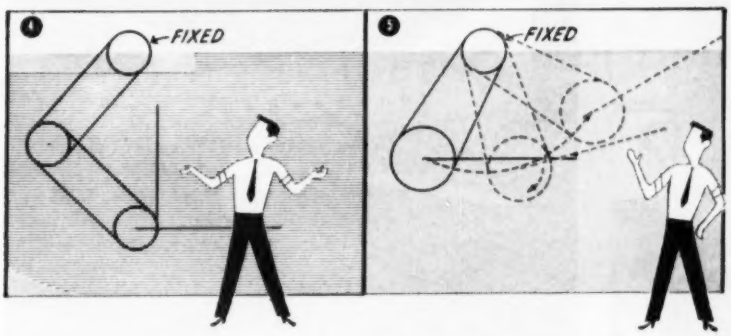
Start with a parallelogram somewhat like this. Visualize one of its short sides anchored to the top of a drawing board parallel to your base line, and let the remaining three sides be free to move together. Add a projecting straightedge to the bottom side as shown, and it will theoretically stay parallel to the base line. Parallel lines could be drawn anywhere within the shaded area above. But clearly, that field of action is too limited.

To obtain parallel motion over the entire working surface of the board, a second parallelogram could be coupled to the bottom of the first so that both have one short side in common. An elementary drafting machine would result . . . at least in principle. In practice, it would fall short because the slightest play at any of its 8 joints would create gross error at the straightedge.

What is needed is a better mechanical design based on the same parallelogram principle. Take a pair of rotating drums, connect them with a tight steel band, and the assembly will behave like a parallelogram if the drum diameters are equal. Now couple a second band-and-drum assembly to the first in such a way that they have the middle drum in common . . . and you have the basis of a modern drafting machine.

and find out WHY— BETTER!"

The Right Angle



The band-and-drum machine, with all three drums of precisely equal diameters and with bands which will not slip, will draw absolutely parallel lines over the entire working area. But if the drum diameters are not equal, the parallelogram principle is violated and the machine cannot draw parallel lines. The greater the difference in diameter the more the lines will be out of parallel.

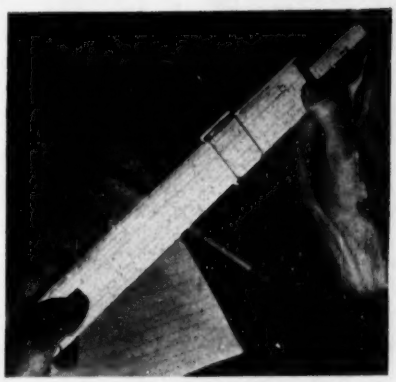
Here, in exaggerated form, is what happens when two of the drums are not equal in diameter. This could occur in either arm of the machine, conceivably in both arms with the errors being additive. From this it is clear that a central factor in the accuracy of a drafting machine is the accuracy of all drum diameters. That is why K&E goes to very extraordinary lengths in this regard in building PARAGON Drafting Machines.

These basic principles and the advanced engineering design in the PARAGON combine to give you the finest in drafting machines. You realize this as soon as you place your hand on the controls.

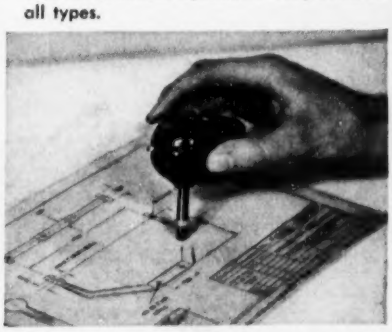
The scales rotate freely with the lightest pressure on the protractor control ring. Release it and they are locked at the nearest 15° position. Intermediate angles are easily set.

Another PARAGON feature is the open center construction of the arms. Even when they are twisted by lifting the head of the instrument off the board, it is impossible to disturb the factory-set band tension.

Ask your K&E Distributor or Branch to tell you about other PARAGON features or give you an actual demonstration.



An engineer without a K&E Slide Rule is like a doctor without a stethoscope. It's the badge of the profession . . . with good reason. The first American-made slide rule was a K&E, and generations have known these rules for their precision, readability and velvet-smooth operation. They come in all types.



After you've once used a K&E MOTORASER,† you'd no more go back to hand erasing than you'd take to drawing with your gloves on. With MOTORASER you can either pin-point your objective, or cover a larger area without damage to the drawing surface. Runs on 110 volt 60 cycle AC, or DC with an inexpensive adapter.

†TRADE MARK

K+E

PARTNERS IN CREATING

KEUFFEL & ESSER CO.

Drafting, Reproduction, Surveying Equipment and Materials, Slide Rules, Measuring Tapes

NEW YORK • HOBOKEN, N. J.

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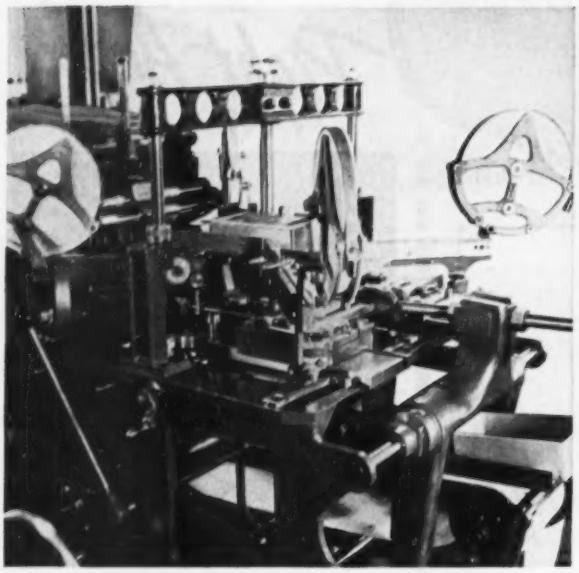
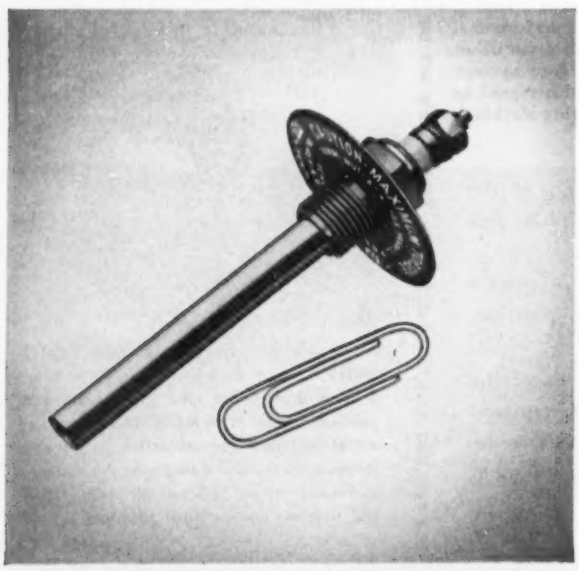
Mighty Midget THERMOSWITCH® Unit bosses temperature in tight spots

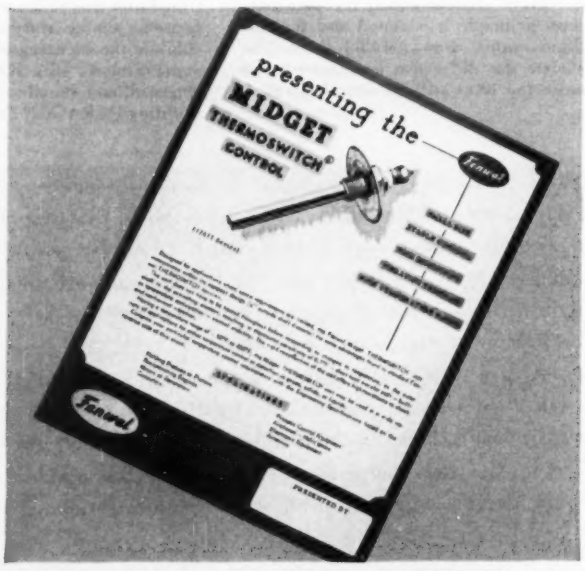


1. THE HEAT'S ON in this box making machine — heat-sealing box corners. Speed of boxes passing through determines desired temperature. Four Fenwal Midget THERMOSWITCH units control the four heaters precisely — yet must do their work in very tiny space. Only Fenwal Midgets could do it!

2. SHOULD OVERHEAT OCCUR in this transport plane's cabin heater the Fenwal Midget THERMOSWITCH Thermostat would detect it instantly and positively. It snuggles into a tiny space — the heating system's fuel accessories box; measures only ¼" diameter by 3⅛" but does its job like a Marine.



3. THE SHELL TELLS ALL on a Fenwal THERMOSWITCH because the shell itself is the heat-sensitive element. It expands or contracts instantly when a temperature change occurs, opening or closing electrical contacts. It is rugged, resistant to corrosion and vibration, compact and always dependable. This is why they are in use on so many control and safety devices.



4. FOR FREE BULLETIN on Fenwal Midget THERMOSWITCH units just write. It gives detailed information and engineering specifications on this new versatile THERMOSWITCH unit for use in confined spaces. Fenwal engineers are glad to assist on your application problems. **Write Fenwal Incorporated, 54 Pleasant St., Ashland, Mass.**

Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

SENSITIVE... but only to heat

MIDWEST

The Only Change is in the Name

MIDWEST PIPING & SUPPLY CO., INC.
has Changed its Name to

Midwest Piping Company, Inc.

6283

Because the word "Supply" is no longer accurately descriptive of the major business operations of this company, the stockholders have voted to drop it from the corporate name.

There has been no change in management, ownership or business at Midwest . . . and none is contemplated. Only the name has been changed. Midwest continues all its activities in the fabrication and installation of piping, and in the manufacture of welding fittings.

MIDWEST PIPING COMPANY, INC.

Executive Offices: 1450 South Second St., St. Louis 4, Mo.

Plants: ST. LOUIS, PASSAIC, LOS ANGELES and BOSTON

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PIPING FABRICATORS AND CONTRACTORS FOR MORE THAN 50 YEARS
MANUFACTURERS OF WELDING FITTINGS FOR MORE THAN 20 YEARS

WHAT *Life-Line* REALLY DELIVERS IS MORE SERVICE...LESS SERVICING

Only modern motors and controls give you these features

Motors and controls have been built much the same way for years. Motors required frequent lubrication . . . controls needed constant maintenance. But, you can get really modern equipment built to standards that match today's speeded production requirements.

"De-ion®" arc quenching used on Life-Linestarters has proved the most efficient method of increasing contact life and interrupting capacity. Pictured on the left is the exclusive Westinghouse "De-ion" Quencher at work. In 1/120 of a second, arcs are confined, divided, extinguished—a *basic* to long contact life and equipment protection. It's the last word in arc quenching. Combined with silver contacts, this "De-ion" principle eliminates the need for constant contact maintenance. Contacts *never need* filing.

Pre-lubricated bearings on Life-Line motors have introduced new freedom from motor maintenance. You eliminate bearing failures due to overlubrication, under lubrication, and from entrance of dirt into bearings. Result is reduction of motor down time. Certainly, the way to grease a modern motor is *don't*. Results of over half a million Life-Line motors serving every phase of industry show motor failures cut in half!

It's this kind of advanced features that puts Life-Line motors and Life-Linestarters years ahead of conventional equipment. Get all the reasons why. Ask your Westinghouse representative for full details, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21693-A

YOU CAN BE SURE...IF IT'S Westinghouse

DENISON HydrOILics

. . . for longer-lasting efficiency

PUMPS, MOTORS and CONTROLS

"The Finest Money Can Buy!"

Denison Axial Piston Pumps.
Hydraulically balanced, high-pressure, high-volume pumps in a range of sizes for circuits of 3000 and 5000 psi capacity . . . volume capacities 3.5 to 35 gpm. Constant volume, or variable volume with control by hand wheel, pressure compensation, stem, or cylinder. Face, flange or foot mountings. Catalogs P-4-1, P-4-2, P-4-3, P-4-10.

Multi-Range Flow Controls
permit full-scale regulation of flow for many different circuit needs, at pressures to 3000 psi. Infinitely adjustable within each range of control . . . cartridge-type single-spool design adjusts easily to various pump deliveries without changing spools. 2-port and 3-port types, with or without built-in check. ¼", ⅜" and ¾" sizes; 0 to 28 gpm capacities.

Pilot-Operated 4-Way Valves
—with solenoid control—for circuit pressures to 5000 psi. Eliminate spool-sticking during long high-pressure holding cycles. System pressure shifts valve spool; solenoid operates valving only. Catalog VD-1-1.

For more than 25 years, Denison has been meeting Industry's toughest demands for oil-hydraulic equipment—with efficient high-pressure components that have won wide approval for their rugged, compact design and long, low-cost performance.

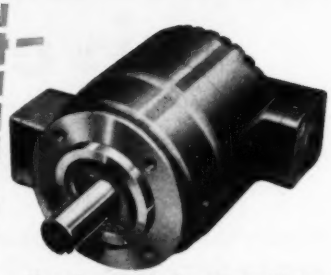
To meet constantly increasing needs, Denison now offers *today's most rapidly expanding line* of equipment for packaged hydraulic power, hydraulic transmissions, remotely controlled equipment, and other requirements for widely adjustable power, speed and control. A few of these HydrOILic components are shown here.

To make sure you get the fullest advantages of oil hydraulics—for variable-speed drives, accurate pressure control, spark-free power transmission, or closely controlled motion of any kind—specify Denison's HydrOILic Equipment.

Write for further details or call your Denison representative today.

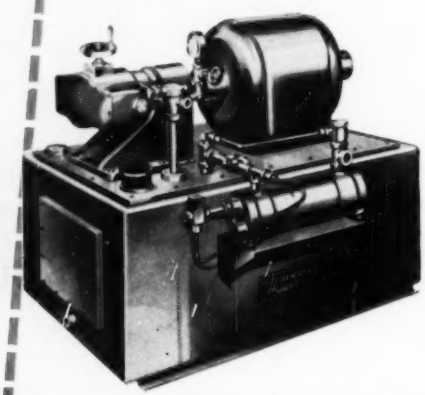
The DENISON Engineering Co.
1189 Dublin Rd., Columbus 16, Ohio

DENISON HydrOILics



Vane-Type Single-Stage Pump/Motors,
built for continuous use at pressures to 2000 psi, are ready for either pump or fluid motor duty without alterations. Rotation of shaft can be either direction without internal adjustment. Four sizes, plus interchangeable cam rings, offer pumping capacities from 2½ to 70 gpm, or torque ratings from 13 to 257 inch-pounds per 100 psi. Catalog P-5.

Denison Axial Piston Fluid Motors.
Four sizes, with torque capacities ranging from 510 to 5585 inch-pounds (about 24 to 160 HP). Speeds to 2000 and 3000 rpm. Compactly built . . . largest size is only about one foot in diameter. For circuits of 2500 and 5000 psi. Catalogs FM-2 and FM-3.



Denison's Self-Contained Pumping Units.
37 models cover any circuit need from 400 to 5000 psi and from 2 to 35 gpm requirements. Automatic water-cooled oil coolers or two-pass automatic heat exchangers available for extra heavy or continuous service. All operating components mounted on reservoir top in single-panel assembly, for easy removal as a unit. Catalogs PU3 and PU4.

The Bellows AIR MOTOR

is now available with your choice of built-in valve arrangements

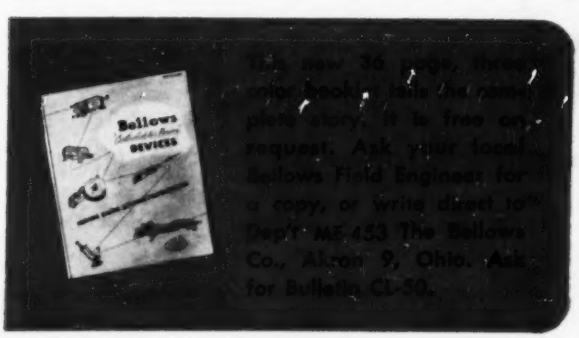
IN DESIGNING for pneumatic operation of equipment, the air engineer can now choose the method of valving he prefers — and still have all the advantages of integral valve and cylinder construction.

The Bellows Air Motor — the only air cylinder with an integral valve—proven in over 150,000 installations —is now available with a range of built-in valve controls that offers the engineer every latitude in pneumatic design.

If he prefers to use momentary contact low voltage control, standard or explosion-proof, Bellows has it. If he prefers 110 volt maintained contact for interlock with established electrical circuits, Bellows has it. If he prefers to control his pneumatic circuits manually, Bellows has it. Or should his designs call for full pneumatically controlled operations, Bellows offers a choice of two control systems.

Basic to all valving arrangements is the time-proven Bellows four-way directional slide valve with its integral controls for regulation of piston rod speed. Basic, too, is the single air connection which may be flexible hose, and which does away with multiple piping. It is in the methods used to shift the directional slide valve that this new flexibility in air control becomes so apparent.

All Bellows Air Motors, with any integral valve control, are available in five bore sizes: 1¼", 1¾", 2½", 3⅜" and 4½" and in stroke lengths up to 48". A wide range of mounting styles further adds to the flexibility of this compact, self-contained power unit.



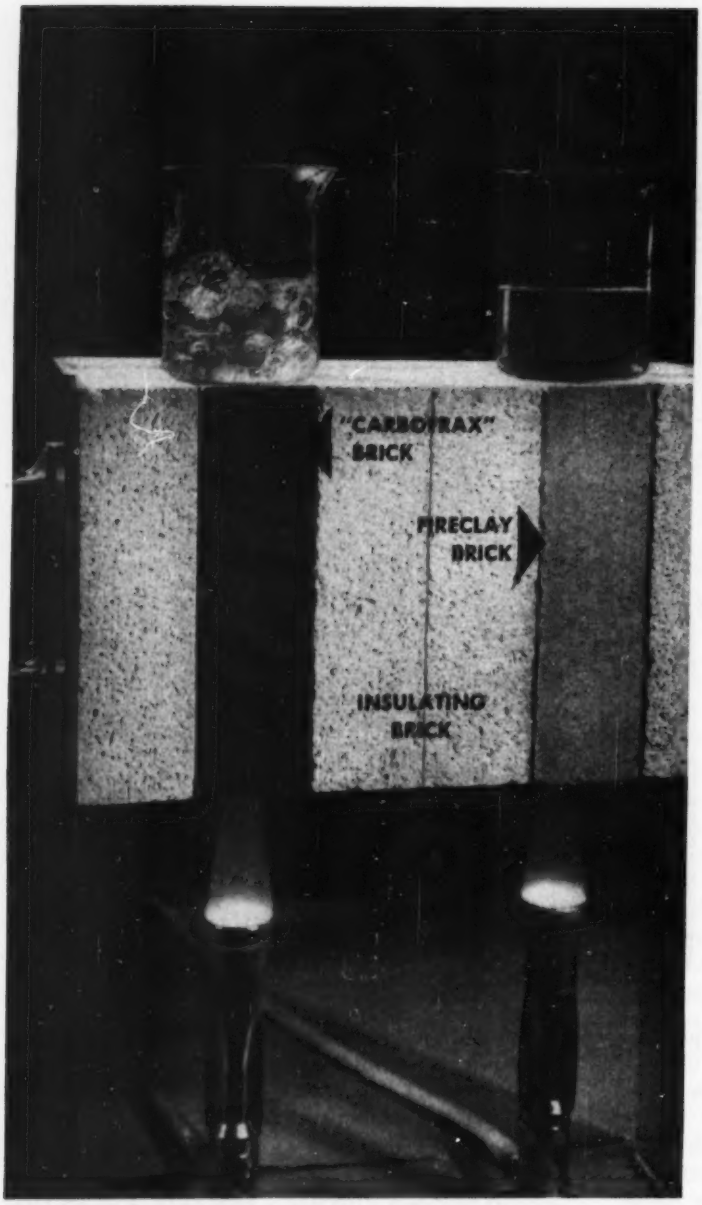
The new 36 page, three-color booklet tells the complete story. It is free on request. Ask your local Bellows Field Engineer for a copy, or write direct to Dept. ME-453 The Bellows Co., Akron 9, Ohio. Ask for Bulletin CL-50.

The Bellows Co.

AKRON 9, OHIO

Bellows "Controlled-Air-Power" for Faster, Safer, Better Production

692A



Two Meeker burners, two bricks — but see the difference! The beaker on the CARBOFRAX brick boils furiously (through *the length* of a 9" brick). The water on the fireclay brick is barely tepid.

Could you use a

Refractory that transmits heat

. . . as rapidly as chrome-nickel steels?

Here's a refractory that, in certain respects, is more akin to heat-resisting metals than to refractories. CABOFRAX silicon carbide refractory (same basic material as CARBORUNDUM brand abrasive) is, in many ways, one of the most indestructible of materials. At 2460 F., it has a crushing strength of over 10,000 psi. It is inherently resistant to even the most severe abrasion—often outlasting alloy parts, 5 or 10 to 1. And it can be used at temperatures up to and exceeding 3000 F.... roughly 1000 degrees over the upper limits for metals!

But, most important, at elevated temperatures these refractories conduct heat approximately as fast as chrome-nickel steels. This is 11 to 12 times faster than fireclay refractories!

Thus CARBOFRAX refractories are ideal for radiant tubes, muffles, hearths, and other equipment using *indirect heating*. Since they absorb and release up to five times as many BTU's per second as fireclay, they are also perfect for *heat exchange* equipment, such as checkers or recuperator tubes. Conversely, these refractories play an important role where heat must be *dissipated* (e.g. arc shields, pot linings, etc.).

Do any of these applications suggest possibilities? If so, please write or phone us. And be sure to get our easy-to-read 20-page booklet. It describes the many unusual properties of our Super Refractories line. No obligation, of course.

Dept. P-43, Refractories Division
The Carborundum Company, Perth Amboy, N. J.

Send complimentary copy of Super Refractories Booklet to:

NAME _____

POSITION _____

COMPANY _____

STREET _____

CITY _____ ZONE ____ STATE _____

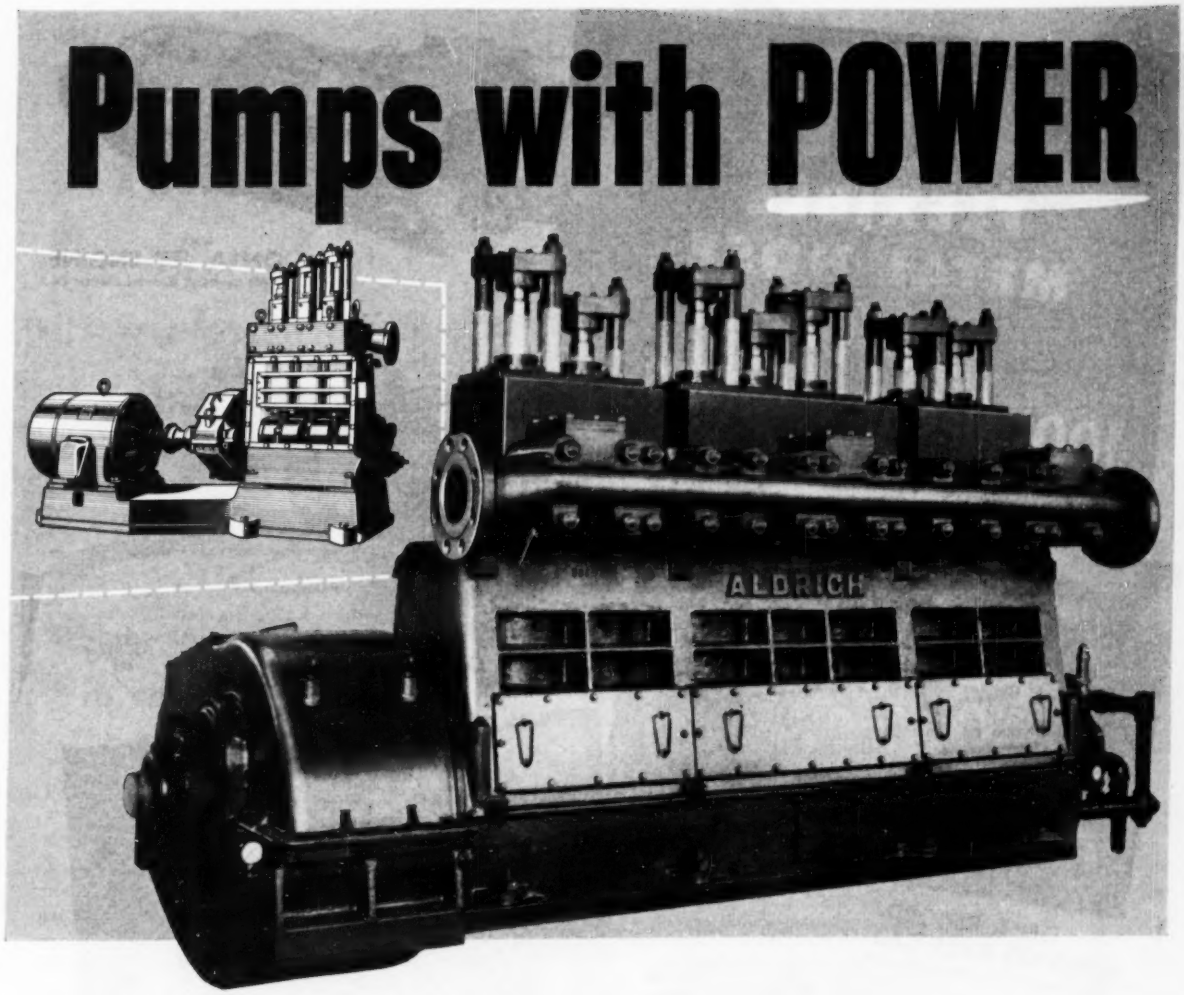
Super Refractories by

CARBORUNDUM

Trade Mark

"CARBORUNDUM" AND "CARBOFRAX" ARE REGISTERED TRADEMARKS OF THE CARBORUNDUM CO.—WORLD'S LARGEST MANUFACTURER OF SUPER REFRACTORIES

Pumps with POWER



Aldrich Direct Flow Pumps deliver real *power*—the kind of power that makes them ideal for a host of pumping applications throughout industry.

These power pumps are widely used on jobs like hydraulic systems for press operation; plastic and rubber molding and extrusion; die casting and steel mill descaling, and many uses in the petroleum and chemical industries.

The reason Aldrich Pumps are "extra-powered" is simple. *Higher operating speeds*—in pumps that are relatively light, small and compact—result in greater *pressures* and *volumes.*

Added power like this means more *work* from lower cost units. You'll get this basic advantage when you choose Aldrich—plus other cost-cutting features like sectionalized fluid ends . . . changeable plunger sizes . . . interchangeable moving parts . . . and reduced space requirements.

Aldrich Direct Flow Pumps are manufactured in 3″, 5″ and 6″ stroke sizes, in Triplex, Quintuplex or Septuplex models (50 to 900 hp). Pictured here are a 700 hp Septuplex and a 100 hp Triplex. For more information about Aldrich Direct Flow Pumps write for catalogs, engineering service, or a representative's call.

THE ALDRICH PUMP COMPANY

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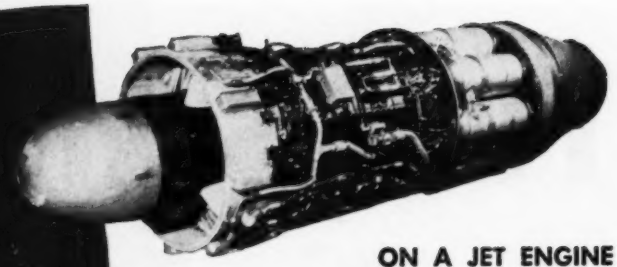
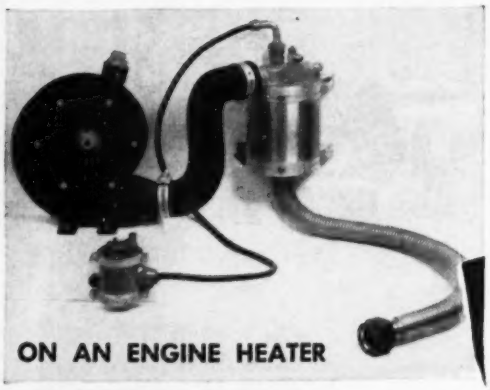
CMH FLEXIBLE METAL HOSE answer to 1001 design problems . . .

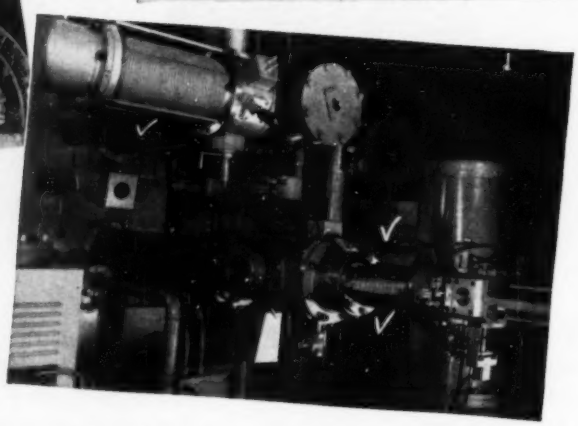


ON A JET ENGINE
(Photo courtesy, General Electric Co.)



ON AN ENGINE HEATER

ON A RECORD-HOLDING RACE CAR
(Photo courtesy, Cummins Engine Co.)



ON A POSITIVE ION ACCELERATOR
(Photo courtesy, High Voltage Engineering Corp.)

The Flexible Metal Hose Design Guide gives detailed data on types, sizes and characteristics of CMH hose. Write for your copy today, or see complete hose specifications in Sweet's Product Design File.

In any product where liquids or gases must be conveyed under conditions of vibration, expansion and contraction, misalignment or flexation, there is a design problem that can be answered with CMH Flexible Metal Hose.

CMH Flexible Metal Hose is available in a variety of corrugated and convoluted types, in steel, bronze, stainless steel and other alloys and in a complete range of diameters for every application. Whatever your product, if motion or misalignment exists in fluid conveying lines, it will pay you to consider CMH Flexible Metal Hose. Just send an outline of your problem and we will make recommendations.

CHICAGO METAL HOSE Division

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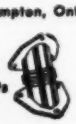
Flexon identifies CMH products that have served industry for over 50 years.

CMH

Flexible metal hose

Expansion joints

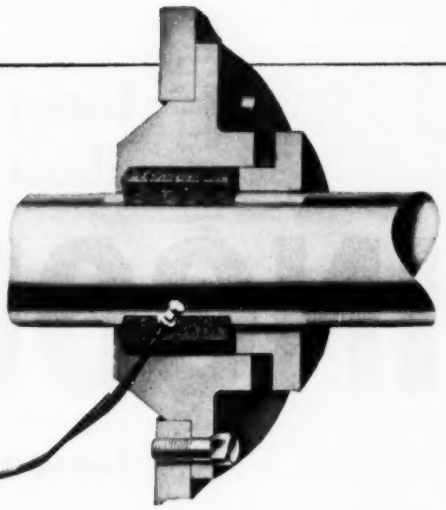


Aircraft components

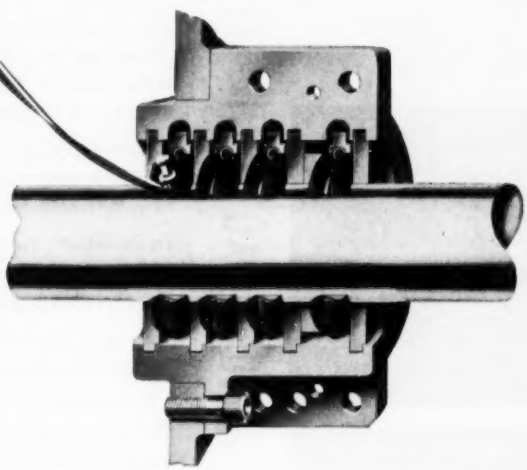
Metallic bellows

COPPUS TURBINES

offer you a choice of packing rings



STANDARD METALLIC RING PACKING — Made of high grade asbestos cores encased in specially treated lubricated aluminum foil. Recommended as a low-friction, long-service packing for steam temperatures up to 850 F and back pressures up to 50 lb. Adjustable packing glands keep leakage at minimum. Easy access to packing rings.



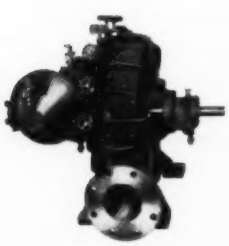
OPTIONAL CARBON RING PACKING — Consists of three carbon packing rings on the pressure side and one beyond the leak-off section. Each ring has three segments held together by a stainless steel garter spring. For back pressures up to 75 lb. Standard for vacuum or gas operation, or when leak-off is desired.

Heavy chrome plating on shaft at stuffing box is common to both types of Coppus packing.

Coppus Turbines ranging from 150 hp down to fractional in 6 frame sizes

FIT TURBINE COSTS TO HORSEPOWER NEEDS

When you buy turbines rated close to your exact horsepower needs, you save plenty of money. That's because turbines are generally priced in proportion to their size. The wide range of sizes of Coppus Turbines promises purchasing economy for you from the 150 hp size down to the smallest. As for operating and maintenance economies, you get them, too, from such other features as: greater number of manually operated valves for individual control of steam nozzles; replaceable cartridge-type bearing housings and others. For complete details . . .



WRITE FOR BULLETIN 135
COPPUS ENGINEERING CORPORATION
364 Park Avenue
Worcester 2, Mass.
Sales offices in THOMAS' REGISTER

COPPUS "BLUE RIBBON" TURBINES

INCOLOY INCOLOY INCOLOY INCOLOY INCOLOY INCOLOY INCOLOY INCOLOY INCOLOY

Latest facts about

INCOLOY

Newest member of the Inco family

Incoloy® was developed as a companion to Inconel®, long considered one of industry's most durable high temperature metals.

The latest test results now definitely establish the importance of Incoloy as a new high temperature material. (See tables.) In fact, its most useful mechanical properties are comparable to those of Inconel at temperatures up to 1800°F.

Both metals offer good resistance to oxidation. But Incoloy, having a lower nickel content, is likely to provide greater resistance to sulfur attack.

In structure, Incoloy is stably austenitic, and shows no tendency to become embrittled by precipitation of sigma or carbidic phases after prolonged exposure to intermediate temperatures.

Note also, in the tables, the important preliminary creep and rupture data which have been developed on Incoloy.

Like Inconel, the new alloy is readily workable, both hot and cold. Its rate of work hardening is practically the same as that of Inconel. And Incoloy can be welded by commonly-used methods.

All of the usual mill forms are produced — billets, rounds, flats, hexagons, sheet and strip, rods, tubing and wire. Consult your distributor of Inco Nickel Alloys for the latest information on availability from warehouse and mill. And remember — it usually helps to anticipate your requirements well in advance.

Remember, too, that you can always call on Inco's High Temperature Engineering Service for assistance in selecting the *right* metal for any high temperature application. All you need do is write and ask for a copy of the "High Temperature Worksheet." This is a simplified form especially designed to help you highlight the essential facts of your particular problem. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

Incoloy
Preliminary Creep and Rupture Data
Condition: Course Grained-Annealed*

Creep

Temp. F	Stress, psi, to Produce a Minimum Creep Rate of .01% 1000 hrs.	.10% 1000 hrs.
1400	4400	5500
1600	2000	2900
1800	250	500
2000		200**

Rupture

Temp. F	Stress, psi, to Produce Rupture in: 1000 hrs.	10,000 hrs.	100,000 hrs.
1400	8700	6000	(4200)
1600	3800	2200	(1300)
1800	1700	1100	(670)
2000	850	(540)	

*2 hrs. 2050°F AC
**.07%, 1000 hrs. (4000 hrs.)

INCO TRADE MARK

Inco Nickel Alloys

Incoloy... *for Heat-Resisting Applications*

MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 75 NUMBER 4

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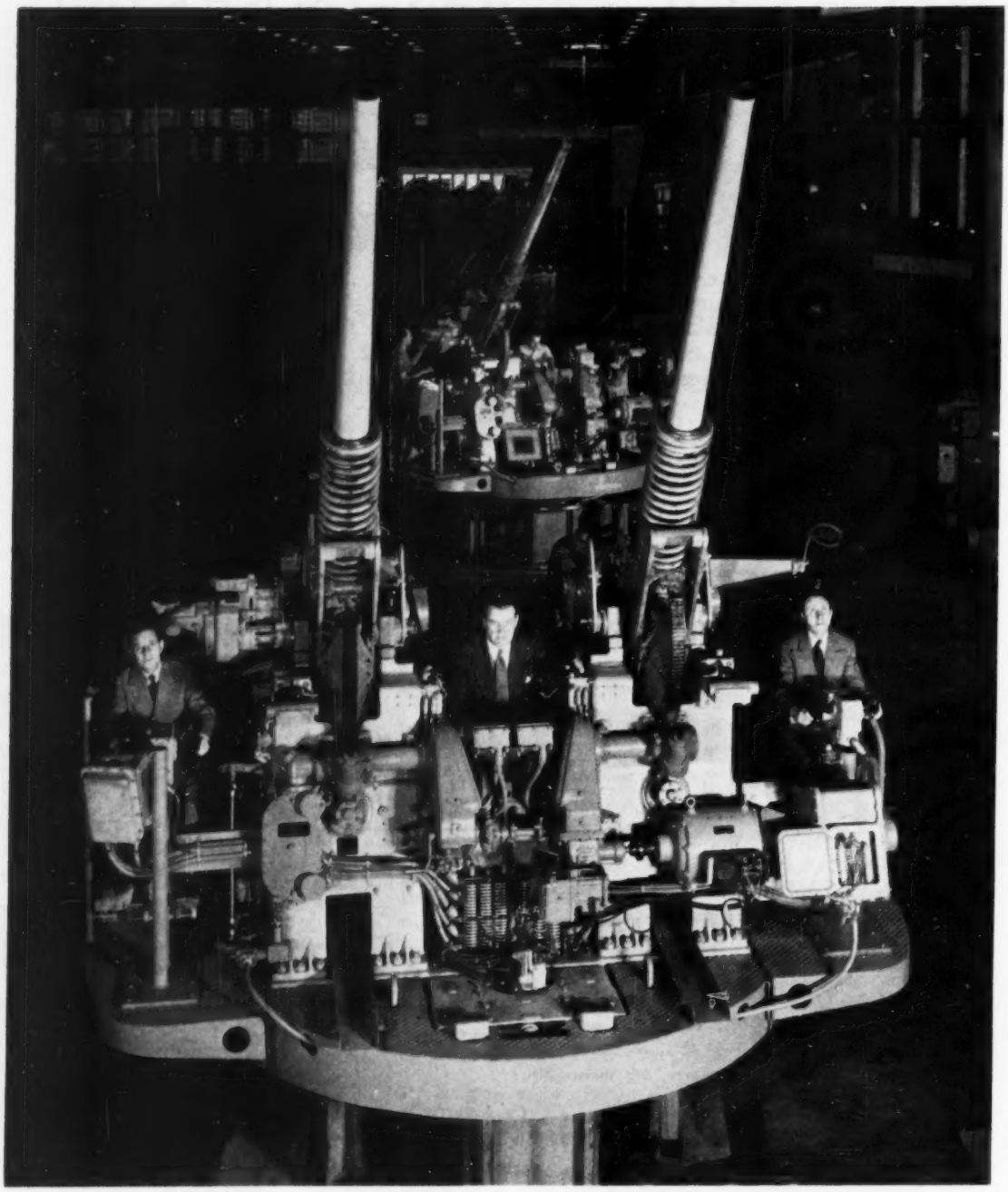

Electronically Controlled Gun Mounts for the U. S. Navy

(First 3-in., twin-fifty gun mount, weighing 17 tons, being produced by the Firestone Tire & Rubber Company, Akron, Ohio, is pictured above. Equipped with automatic loading devices and intricate radar fire-control systems, the guns will hurl 3-in. shells at low or high-flying aircraft. The center firing station is the captain's seat; he is the fire-control officer of the gun when it is operated independently from the ship's central fire-control station. When the gun is locally operated against aircraft, it is sighted and fired from the gunner's station at the left. When the gun is locally operated against surface objects it is sighted and fired from the gunner's station at the right.)

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No. 4

MECHANICAL ENGINEERING

APRIL
1953

GEORGE A. STETSON, *Editor*

A Program for Engineering

EVERYONE recognizes that as engineering advances it becomes more diversified and complex. Few there are who are not conscious of the influences which engineering exerts on human affairs or of the part engineering plays in creating and maintaining a high level of material well-being in this and in any other nation where it is allowed to prosper. Nor are those who sense these aspects of engineering unmindful of the growth, importance, and influences of other elements affecting life today without which engineering could not have attained its present status.

If we attempt to forecast the future of engineering, the conviction becomes clearer and stronger that engineering progress is more than the growth of technical knowledge and competence. Progress in engineering will depend also upon progress in other aspects of contemporary life which determine the political, social, and cultural environment in which we live. The discoveries of science and the application of these discoveries to improvements in material well-being and the understanding of the physical universe; the development of political and social institutions based on a widespread acceptance of a philosophy that recognizes human rights and opportunity; a government by law wisely, justly, and uniformly administered; an enlightened theory of organization in which economics, psychology, and biology are of significant concern; an educated citizenry whose individual members are as willing to accept their responsibilities as they are to stand up for their privileges; universally accepted ethical practices and codes of private and public morals—these are some of the elements affecting the further successful progress of engineering. They must be considered in any program for engineering.

It must be admitted that engineers and associations of engineers, like The American Society of Mechanical Engineers, have more direct obligations and responsibilities in the cultivation of some of these elements than in others. But engineers and engineering societies will fail their fellow men and their profession will fall far short of its greater mission if they do not consciously attempt to understand and foster all elements of the environment in which engineering itself makes its greatest progress.

Tyrants can and have made use of science and technical skill to perform spectacular feats of engineering, but not in the true spirit of engineering, which is service to mankind. The tombs of the Pharaohs may be permanent monuments to engineering skill, but they also remind us of thousands of men who lived and died under the lash of the slave driver. Science and engineering have made slavery unprofitable in most parts of the world, but there are still systems of government under which the scientists and engineers are not free to work for the best interests of free men. Where engineering is free to direct "the great forces of power in nature for the use and convenience of man," it prospers and ennobles those who practice it. A program for engineering must include preservation of this freedom.

Through the variety of engineering organizations in which they are employed—industrial, business, educational, and governmental—engineers serve their fellow men by exercising their professional skills. Through their engineering societies, engineers serve themselves by pooling their knowledge for mutual advantage, by engaging in projects which stimulate the growth of their profession, and by fostering the ideals and objectives which mark them as professional men. In all of these areas the advancement of technical knowledge and competence is of primary importance, with service to themselves and their fellows as the motivating spirit. Further development of the professional spirit must be part of a program for engineering.

Important also to a program for engineering is a high quality of elected membership. Quality is not entirely gaged by achievement, for if it were, an engineering society would be little more than an honor group of men whose principal work has been accomplished. Promise of achievement, as well as actual achievement, must be recognized if a virile progressive society is to be maintained. The vision, energy, idealism, and ambition of youth are essential to progress. Obvious corollary elements are ability to grow and adaptability to change. If industrial members have these qualities the organization will probably have them also.

It goes almost without saying that the program should be directed toward the advancement and interchange of technical knowledge, that this knowledge should include all stages from research to standardized practice, and that it must range from scientific fundamentals and generalities to highly diversified specialization. The driving demands of modern living standards and the competition among businesses for solvency and survival are powerful stimuli for the advancement of technical knowledge and skill. In order to play his part every engineer is under compulsion to acquire and maintain a high level of specialized competence and knowledge. The techniques of uncovering, analyzing, classifying, and utilizing technical knowledge are so highly developed today that there is little fear that this source of progress will dry up.

Programs of engineering societies have traditionally included the dissemination of technical knowledge and they will and should so continue. Such programs, however, generate problems and the need for expanded programs. Specialization, essential as it is, begets diversification and proliferates in a rapidly growing literature so voluminous that none can read it all, and even digest and index services become cumbersome and expensive. The great tree of engineering knowledge, rooted in the fertile soil of science and technology, has enormous branches from which spring lesser limbs and twigs and a foliage of leaves, each complete and perfect in itself, but moving in isolation from one another. Essential as leaves are to the life of the tree, detached from it they serve no purpose but to enrich the soil that feeds the roots. High on a program for engineering, therefore, is the problem of stimulating essential specialization, providing at the same time a feedback into the great body of general knowledge and a stimulus to further proliferation through contact with other fields of specialization. Meetings and publications provide a means of realizing these objectives.

Engineering, which originated in the mechanic arts and was later enriched by mathematics and the physical sciences, merges ever more intimately with other branches of knowledge and endeavor. Particularly with the progress of the industrial revolution has engineering merged with business and economics. In fact, it is quite as essential that a project be economically sound as it is that it be based on sound engineering. It is to the credit of the founders of The American Society of Mechanical Engineers that they recognized this interdependence. This recognition was based on the fact that the founders were businessmen as well as engineers. Robert Henry Thurston, in his inaugural address as first president of ASME, gave it as his opinion that the Society should be concerned with the management of enterprises, and in 1886 three papers on economic subjects led to a discussion which all but set up within the Society an "economics section." Later, following the great work of Taylor, Gantt, and the Gilbreths and on the crest of a wave popularly known as "scientific management," the economics section of 1886 appeared as the ASME Management Division. Even today there are engineers so steeped in their specialties and so isolated from the main stream of industrial civilization in which engineering is a powerful current that they do not recognize "management" as engineering. True it is that they can cite lack of rigorous analysis and accurate measurement in physical terms, and a large element of "common sense" and illogical situations and conduct as evidence of an "art" rather than a "science."

When Taylor attacked the problem of cutting metals, in which he found more than twoscore variables, some there were who were skeptical of his attempt to carry on a rational analysis of his subject. The field of management abounds in irrational and illogical situations and even more variables than Taylor tackled, but men of vision and courage are invading it bit by bit. They call to their aid a variety of sciences, pseudo sciences, and areas of knowledge, and they are making progress. A problem in the physical sciences, abstruse or complicated though it may be, is simple compared to one which involves apparent imponderables and human relations. But who shall say that this twilight zone may not some day be illuminated by the vision, courage, and persistence of these men? And who can doubt that progress in this field will be as great a contribution of engineering to the welfare of man as any we have known to date? Surely a program for engineering should include the advancement of management and a rebirth of the genius and enthusiasm of Taylor.

Space does not permit discussion of the relationship between engineering and such fields of study as psychology and biology which grow closer year by year and introduce further problems of understanding, interpretation, and vision to adapt into one field the knowledge and techniques of another. But a program for engineering should include consideration of these relationships. And closer to our own field, yet new and unaccustomed to many of us, are the advances being made in the "automatic factory" and automation, touched on by C. J. Jacoby, 3rd, in our October, 1952, issue, by Norbert Wiener in our February, 1953, issue, by H. L. Waddell in our March, 1953, issue, and by Donald P. Campbell in our current issue. These papers are suggestive of fields that should be included in a program for engineering.

No one can speculate on what may be the progress of engineering during the next couple of decades without including the possibility of its further expansion into fields not yet conquered by rational analysis and the tremendous task which awaits those who attempt to correlate apparently unrelated specialties into useful engineering developments. Yet both of these should be included in a program for engineering.

The Board on Technology of ASME was organized for the purpose of co-ordinating the specialized functions of its research, professional divisions, meetings, and publication activities. Its additional and most important purpose—the one which bears most directly on a program for engineering—is to foster technical developments in the older recognized branches of mechanical engineering and to enrich the entire field and the men who practice in it with new knowledge and techniques on the frontiers of engineering and by a cross fertilization from one area of specialization to another and from other branches of knowledge, experience, and endeavor to engineering.

Development of this portion of a program for engineering is difficult. But the rewards are great. When engineering becomes more than the sum of its countless specialties and produces the leaders and the means through whom and by which each man can enjoy all the freedoms that are his right, including that of fulfilling his own destiny, the world will cease to think of engineers as useful and competent technicians and look to them for guidance and the administration of large affairs. Happily, progress is already under way in the fields of production and industrial administration. Important on a program for engineering is the development of men of vision who have the courage, stamina, technical competence, and sense of dedication to the service of their fellow men to convert their visions into reality.

DYNAMIC BEHAVIOR *of* LINEAR PRODUCTION SYSTEMS

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PRODUCTION PROCESSES

PRODUCTION processes may be regarded as combinations of men and machines (provided with finite capital) whose purpose is to make raw material, equipment, and goods available for human wants. Thus, men dig in the earth for ore; other men transport this ore; still others smelt it. Ingots are formed and rolled into metal plates; the plates are fabricated into ships; and the ships in turn transport ore that other men have dug. And so it goes on—an endlessly complex aggregate of interacting and mutually influential activity. Sometimes the production process is more confined: Raw materials are bought; they are stored; after purification they are mixed and transported to a chemical reactor. A desired product is formed along with waste. The product is separated from the waste, cleaned, packaged, and stored or transported to consumers. Whether the production process be that of making cinder blocks, steel strip, or synthetic drugs; whether the process be extensive or small, complex or simple; important similarities can be noted for all production processes that make up our modern industrial complex.

Production processes are "systems"—systems of men and machines working in harmony to manufacture specified numbers of articles according to predetermined standards of quality. Within a production system, subdivision of the operations of the men and machines can be made until "unit processes" can be defined. Thus large systems may be looked upon as interconnected smaller systems. Each smaller system can be reduced even further until the most elementary subdivisions of the production operation can be defined. These most elemental or basic process operations are called "unit processes" or "unit operations." For example: A steel rolling mill takes in ingots and puts out steel plates rolled to specified thickness and cut to specified length and breadth. The essential unit-processing steps involved are moving the ingot to the heating pit, heating the ingot, transporting it from the heating pit to the rolling stand, rolling it to proper thickness, transporting the rolled sheet to the cutting stand, cutting to dimensions, removing waste pieces, storing the finished plate. Thus the unit processes are mechanical handling and transportation, heating, rolling, transporting, cutting, and storing.

Materials flow through production systems continuously or quasi-continuously, when processes are viewed in a macroscopic sense. Raw materials enter processes more or less steadily and finished products leave more or less steadily. Even in batch processes, a certain continuity of action is exhibited because consecutive batches are made at nearly regular intervals of time. The flow of material through a production system, however, does not in itself serve to define unit operations and their interconnections in the production system. Production processes have inherently in their pattern of operation a flow of intelligence: Information is communicated from one group of humans and robots to another so that the human and robot operators or controllers are able to manipulate the machinery of production. The manner in which this information is transformed from a message into an action in the successive steps of a production process becomes the basis for subdividing complex processes into their unit operations. The ultimate aim is to choose the unit processes so that a quantitative mathematical definition can be given their behavior patterns.

Mathematical continuity assigned to the action of material and information passing from one unit operation to another in a production process should not be misunderstood to imply a "steady state of operation" for the process in the dynamical sense. Quite to the contrary, unit processes, small systems made up from unit processes, and finally the full-scale production systems are subjected continually to a variety of external and internal disturbances which cause them to deviate from their steady state of operation. In fact, a steady state of operation rarely exists. Shutdowns, start-ups, interruptions caused by human or machine errors, constitute the normal rather than the exceptional state of affairs.

The disturbances which upset the equilibrium of production processes are manifold. First, there are the desired disturbing forces. Forces are brought to bear upon the material moving through the process by means of the processing machinery so that raw material can be transformed into a finished product. These forces are produced by the machinery according to the dictates of human operators or automatic controllers. The commands supplied to the human and robot operators are in turn provided by their supervisors. Then there is a large group of external disturbing forces which may or may not be desired. These are the disturbing forces which are not under the control of the humans or robot operators or supervisors guiding the operation of the production process such as weather, impurities in raw material, changes in moisture in the air, the wear and failure of machines, power failures, and a multitude of other disturbances.

TECHNIQUE OF QUANTITATIVE ANALYSIS AND SYNTHESIS

Linearization[1] of the unit processes and the linearization of their behavior in groups which constitute production systems permit the formulation of the concept of "production-system circuit theory." Unit processes and groups of interconnected unit processes have command points and load points. They have the aspect of mechanical or electrical networks but they constitute active systems because the energy for causing production comes from power sources located externally to the

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[1] To those people who wish exact treatment of the problem, the assumption of linearization will be unacceptable. To those people willing to tolerate an "engineering approach" to the problem in which "linear behavior" means "essentially linear behavior" and where errors of 25 per cent in the results are weighed against complete failure to perform an analysis, the assumption will not be considered as limiting the work which is proposed.

message and intelligence pathways. For this reason, although production-process dynamic behavior becomes subject to study by the well-organized mathematics of circuit analysis common to electrical engineering and communication theory, servomechanisms theory can be applied to the study of production systems with greater facility because of the almost identical nature of the problems in the two fields.

Unit processes can be studied to determine their linear differential equations. These equations when transformed yield operators or transfer functions that permit us to define "input-output" characteristics for the unit processes. Signal-flow diagrams can then be formed which show the interrelations between the unit processes as material or commands "flow" through the production process. Cascades of unit operations, feedback arrangements with one or more paths, and systems of unit processes upon which external disturbances and external commanding forces act can be recognized. By means of mathematical simplification techniques found in servomechanism theory, the signal-flow diagrams which represent production processes can be reduced to a relatively small number of basic forms. Through the use of servomechanism theory, the performance of these basic production-process systems then may be analyzed or synthesized.[2] Analysis studies of production-system dynamic behavior will serve generally as a means for understanding better how one must synthesize new production systems. Further, the background gained in analysis work will enable the person who prepares quantitative studies of production-system dynamics to judge with considerable certainty the merits of different unit operations, and analysis work may encourage the invention of new combinations of unit operations that will achieve improved production-system response patterns.

UNIT PROCESSES

The unit processes which serve to define many production operations are yet to be defined because of lack of reliable data. However, many unit operations can be reduced to a relatively simple set of mathematical operators. These are proportional action, integrating action, rate action, transportation lags, and exponential lags. Quadratic process operators may be encountered when S-shaped response curves or resonant types of response curves generally found in more complex unit operations or in systems comprising several unit operations process operators must be defined. The mathematical operators associated with these unit process operations become

Proportional action ..... K

Integrating action ..... $1/s$

Rate action ..... s

Transportation lag ..... ϵ^{-as}

Exponential lag ..... $\dfrac{1}{\tau s + 1}$

S-curve action ..... $\dfrac{1}{\tau^2 s^2 + 2\zeta\tau s + 1}, \zeta \geqslant 1$

Resonant action ..... $\dfrac{1}{\tau^2 s^2 + 2\zeta\tau s + 1}, \zeta \leqslant 1$

"Proportional action" is self-evident. Response is in proportion to command, $R = KC$. The constant K may be greater than, equal to, or less than unity. "Integral action" defines how a quantity builds up in proportion to the integral with respect to time of another quantity, $R = (1/s)C$. Thus, the build-up of stock or the accumulation of material between successive stages in production processes illustrates integral action. "Rate action" is best defined as in a mathematical sense as a derivative. It signifies a situation where the rate of change of a quantity in a production process is in proportion to another quantity; thus $R = sC$. Transportation lag, or a dead time, is encountered most commonly when materials are moved from one place to another in a production system, or when the groups, humans or machines possibly computers, responsible for directing the action of human operators, robot operators, or production machinery show periods of indecision. The mathematical definition becomes $R = \epsilon^{-as}C$ where a is the lag or dead time in seconds, minutes, or hours depending upon the particular time scale. Exponential lags are common throughout the whole of dynamics. They are found whenever the rate of change of quantity with respect to time is in proportion to the magnitude of the quantity. Thus, the response $R = [K/(\tau s + 1)]\,C$ can represent the lag in build-up of production, inventory, purchase requisitions, or the temperature of furnaces for firing ceramic parts.

By means of the foregoing mathematical operators which define the transfer functions for unit processes, one can prepare signal-flow diagrams for many elementary production systems. The command and load can be assigned individual mathematical operators, the interconnection of unit processes can be made clear. By simplifying the production-system signal flow diagrams it becomes possible to determine the manner in which a particular production system will respond to a wide variety of command disturbances. An attempt will be made in the next section to analyze the performance of an elementary production process by means of already existing servotechnique. The unique performance properties that can be assigned to the elementary system will be cited.

AN ELEMENTARY PRODUCTION SYSTEM

A production plant comprises a plant-management group, a manufacturing process, and a stock pile. Assume that shrinkage takes place from the stock pile in proportion to the quantity of finished items in the stock pile. Assume that the build-up or decline of the stock pile results from a net inflow of items which is the difference between the plant-production rate and the demand or load rate for finished products. Let the required quantity of finished products in the stock pile be set by a directing group. The plant management is required to use the error between actual quantity of product available in the stock pile and the required quantity as the basis for raising or lowering the production rate.

Fig. 1 shows a signal-flow diagram for the production system. Q_R is the required quantity of finished product. It represents the "command" given the system. Q_A is the actual quantity of product in the stock pile. The error defined as $\epsilon = Q_R - Q_A$ acts upon the plant management causing it to set the desired production rate P. In turn for a desired production rate P, an actual production rate N results. M is the "load" or demand for finished product on the system expressed in terms of items per unit time. The shrinkage from the stock pile is X.

The following group of mathematical equations and operators serve to define the operation of the various unit processes which comprise the production system:

$$\epsilon = Q_R - Q_A \quad [1] \qquad R = N - M \quad [4]$$

$$P = A\epsilon \quad [2] \qquad T = R - X \quad [5]$$

$$N = BP \quad [3] \qquad Q_A = CT \quad [6]$$

$$X = D\,Q_A \quad [7]$$

[2] In view of the great number of books and treatises in the current literature on servomechanisms theory there seems no need to present a review of the principles of servomechanisms written in this paper. All the known linear theory of feedback-control-system analysis and synthesis can be used for the quantitative analysis of linear production systems.

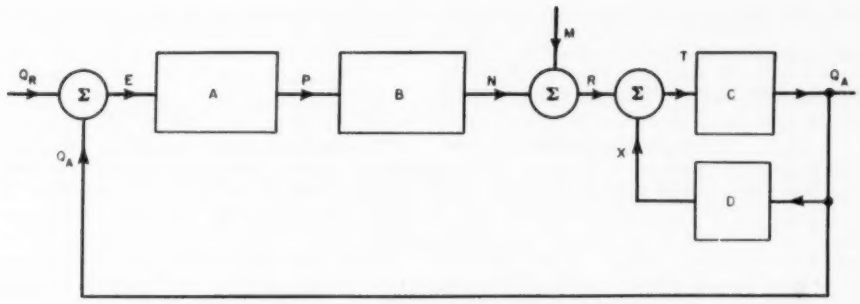

FIG. 1 ELEMENTARY PRODUCTION-SYSTEM SIGNAL-FLOW DIAGRAM

The signal-flow diagram shown in Fig. 1, simplifies successively as shown in Fig. 2 and Fig. 3. From the final simplification of the signal-flow diagram, the relationship between stock-pile quantity Q_A, the desired quantity Q_R, and the load or demand M for product can be written as

$$Q_A = \left(\frac{AB \dfrac{C}{1+CD}}{1 + AB \dfrac{C}{1+CD}} \right) Q_R - \left(\frac{\dfrac{C}{1+CD}}{1 + AB \dfrac{C}{1+CD}} \right) M \quad \ldots\ldots [8]$$

Equation [8] expresses the quantity of items Q_A that will be found in the stock pile at any instant for a given required number Q_R decided by the directors and for a given depletion of the supply under a demand M. There remains now the task of determining exactly what forms the mathematical transfer functions A, B, C, and D can have and what influence their forms can have upon the response characteristics of the production system.

The only possible form for the operator C is an integration defined by the relation $C = 1/s$, because the operator C merely represents the accumulation of stock pile items under the influence of a variable inflow T so that $Q_A = T/s$.

The shrinkage X from the stock pile has been defined as proportional to Q_A at any instant. Thus the operator D must be constant K_1 which may be called the shrinkage-rate constant.

The operators A and B which define the action of the plant management and the manufacturing process, respectively, can have a variety of forms. Here, of course, lies the interesting aspect of the whole study. What forms should they have so that the quantity Q_A can be best placed under control against changes in demand M?

The shrinkage effect may be thought of as degenerative feedback around the integration action which defines the stock-pile build-up. Consequently, the relationship

$$\frac{Q_A}{R} = \frac{\dfrac{1}{K_1}}{\dfrac{1}{K_1} s + 1} \quad \ldots\ldots [9]$$

$$= \frac{K_{sp}}{\tau_{sp} s + 1} \quad \ldots\ldots [10]$$

shows that, in the presence of shrinkage, the build-up or decline of Q_A always will be exponential. The time constant which defines the characteristic time of the stock-pile build-up or decline is $\tau_{sp} = 1/K_1$. The sensitivity K_{sp} also equals $1/K_1$. As the shrinkage approaches zero, however, the build-up becomes truly an integral action.

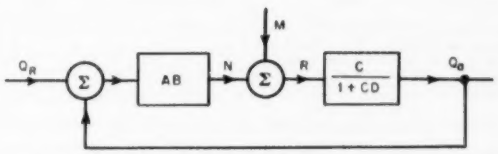

FIG. 2 SIMPLIFICATION OF SIGNAL-FLOW DIAGRAM

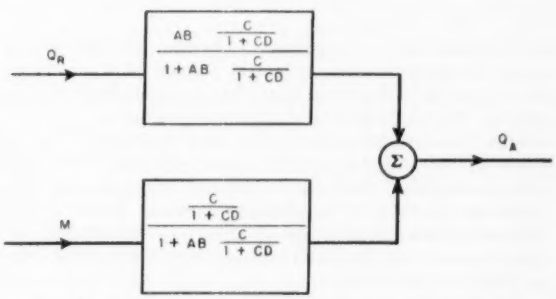

FIG. 3 FINAL SIMPLIFICATION OF SIGNAL-FLOW DIAGRAM

In an effort to keep the analysis short and to avoid lengthy mathematics, assume the production process exhibits an exponential-lag form of operation. Thus, the operator B of the form

$$\frac{N}{P} = B = \frac{K_p}{\tau_p s + 1} \quad \ldots\ldots [11]$$

can be used to define the dynamic behavior of the manufacturing process. The constant K_p is the nondimensional process sensitivity, since both N and P have the same units. The production-process characteristic time τ_p defines the rapidity with which the actual production rate N can reach a sudden new setting of desired production rate P.

Several modes of plant management can be chosen. However, we can limit the choice to proportional or integral action with an exponential lag or a dead time. Possibly both types of lag may occur simultaneously.

Before choosing a particular operator A to specify plant-management action, a clear understanding should be gained of what the production process must do in order that it carry on satisfactorily within some larger business plan or manufacturing pattern. Assume that every month the desired quantity Q_R is set to conform with economic data derived from sales trends, past and present. For changes in Q_R from former values to the new levels, Q_A should reach a new steady state as soon as possible, but at least within about two days. Assume also that in the presence of zero load or demand M, Q_A shall reach 0.9 Q_R

TABLE 1 COMPARATIVE STUDY OF DIFFERENT MANAGEMENT ACTIONS ON PRODUCTION-SYSTEM DYNAMIC PERFORMANCE

Open-loop transfer function, $\frac{Q_A}{\epsilon} = A \frac{K_p}{\tau_p s + 1} \frac{K_{sp}}{\tau_{sp} s + 1}$

where $K_{sp} = 10$; $\tau_{sp} = 10$ days; $\tau_p = 1$ day; $K_p = 1$

Plant-management action	Plant-management operator A	Steady-state operation: $\frac{Q_A}{Q_R}\|M=0$	Steady-state operation: $\frac{Q_A}{M}\|Q_R=0$	Absolute stability	Maximum loop gain for phase margin of 45 deg	Approximate resonant frequency, ω_R radians/day	Approximate transient settling time, days	Approximate Q_A/M for ω less than resonant frequency ω_R
Proportional	$K_{pm} = 1.45$	0.94	0.65	Cannot oscillate. $0 < K_{loop} < \infty$	$K_{loop} = 23$ db or $K_{loop} = 14.5$	1.0	4 days	$0 < \left\|\frac{Q_A}{M}\right\| < 0.64$; $0 < \omega < 1.0$
Proportional with exponential lag, $\tau_{pm} \simeq \tau_p$	$\frac{K_{pm}}{\tau_{pm} s + 1}$ $K_{pm} = 0.56$ $\tau_{pm} = 1.0$	0.85	1.52	Oscillates for $K_{loop} \geq 24$ db or $K_{loop} \geq 16.0$	$K_{loop} = 15$ db or $K_{loop} = 5.6$	0.56	7.2 days	$0 < \left\|\frac{Q_A}{M}\right\| < 1.5$; $0 < \omega < 0.56$
Proportional with dead-time lag, $a = \tau_p$	$K_{pm} e^{-as}$ $K_{pm} = 0.5$ $a = 1.0$	0.935	1.67	Oscillates for $K_{loop} \geq 19$ db or $K_{loop} \geq 9.0$	$K_{loop} = .14$ db or $K_{loop} = 5.0$	0.5	8 days	$0 < \left\|\frac{Q_A}{M}\right\| < 1.6$; $0 < \omega < 0.5$
Integral	$\frac{K_{pm}}{s}$ $K_{pm} = 0.01$	1.0	0	Oscillates for $K_{loop} \geq -0.5$ db or $K_{loop} \geq 0.95$	$K_{loop} = .19$ db or $K_{loop} = 0.12$	0.1	40 days	$\left\|\frac{Q_A}{M}\right\| \cong 100\omega$; $0 < \omega < 0.1$
Proportional plus integral	$K_{pm} \frac{\tau_{pm} s + 1}{s}$ $K_{pm} = 0.1$ $\tau_{pm} = 10$	1.0	0	Does not oscillate for $\tau_{pm} = \tau_{sp}$	$K_{loop} = 0$ db or $K_{loop} = 1.0$	1.0	4 days	$\left\|\frac{Q_A}{M}\right\| \simeq 0.1$; $0 < \omega < 1.0$

in the steady state of operation. Assume the dynamic response of the system to changes in demand M shall exhibit less than 10 per cent change in Q_A for any cyclic fluctuation in demand M up to frequencies of one cycle per day.

With these "specifications" the problem becomes that of choosing the plant-management form of operator A and then setting a series of "limiting" numerical values for the characterizing parameters of the operators A and B. The magnitude of the disturbance M which can be tolerated consistent with the static precision and dynamic response needed for the production process also can be stated.

SYNTHESIS: THE CHOICE OF PLANT-MANAGEMENT OPERATOR

The problem of studying the production-system combined static and dynamic response has now been reduced to such form that we can recognize the issue to be that of designing a feedback type of system which is to be used mostly as a regulator, but once in a while as a follow-up system. Most of the time the production system regulates against the sales or load demand, in an effort to maintain the quantity Q_A in the stock pile essentially constant. The production system operates as a follow-up system whenever the reference quantity Q_R is changed. Upon these occasions it tries to reach a new level of Q_A in agreement with Q_R as quickly as it can.

Clearly, the design of a composite regulatory and follow-up system must be a compromise. The management operator A, if it is to be the same[3] for both modes of production-system operation, must be chosen with the static, dynamic, follow-up, and regulation aspects of the problem in mind. A limited number of choices of the management operator A can be tried out if we resort to tabulating the pertinent information. A graphical approach to the problem seems characteristic and most revealing. This requires that the open-loop transfer function

$$AB \frac{C}{1 + CD}$$

should be plotted under the assumption that the operator A is unity, and that all the gain can be factored out of the operator in the form of a single constant K_{loop} whose value can be determined later. From the nature of the magnitude and phase characteristic for the open-loop operator, it becomes possible to synthesize the production-system dynamic behavior in accordance with the specifications given in the previous section, and hence to design the form and parameter values to the operator A.

Table 1 presents the salient aspects of the production-system performance for a variety of plant-management actions. The data were procured by preparing graphs of the open-loop frequency characteristic Q_A/ϵ, and determining the closed-loop system response Q_A/Q_R and Q_A/M upon the basis of a phase-margin criterion of 45 deg.[4] This procedure made possible the study of the static or steady-state performance, the absolute stability, the selection of the loop gain consistent with a reasonable "degree of stability," the determination of the approximate resonant frequency, and the transient-response settling time.

SUMMARY OF PROBLEM

Proportional action by management is not quite satisfactory. The loop gain can be high enough to meet the "static" performance specification for Q_A/Q_R. However, the production system exhibits a slow transient response, which results primarily from the fact that the stock-pile time constant τ_{sp} is very large. Furthermore, although the loop gain is high, most of this gain is found in the stock-pile constant K_{sp} rather than in the management operator A or the production plant operator B. Hence the production system tends to be unduly sensitive to changes in the load.

Time lags which enter the plant-management action, whether they be of an exponential or a dead-time type, tend to deterio-

[3] There is no reason why the management operator has to be the same under the condition of bringing the plant and its stock pile up to the required level, and under the condition of keeping the plant from experiencing serious upsets because of a widely fluctuating load on the stock pile. It seems practical to have two different kinds of operator, if they are needed, so that the production system will behave in an optimum manner for both kinds of disturbance. The only problem here will be to recognize that the equations which describe the process and describe the switch from one form of operator to another will have to be analyzed properly so that the transient upsets incurred through switching will be treated quantitatively.

[4] "Principles of Servomechanisms," by G. S. Brown and D. P. Campbell, John Wiley & Sons, Inc., New York, N. Y., 1948, p. 189.

rate the quality of the process response even below that found for proportional control. The maximum allowable loop gain diminishes. The static performance becomes poorer. The dynamic response becomes slower by about a 2:1 factor.

When plant management exhibits integral action, the static performance is considerably improved. The presence of the integration reduces the steady-state error in the stock-pile quantity to zero. Thus, Q_A/Q_R approaches unity as the steady state is reached in the presence of $M = 0$. More important, however, is the fact that the variation in Q_A due to steady loads M is reduced to zero. Integral action, however, leads to very poor transient response, since the settling time now becomes more than a month for the particular set of numbers being used.

Also, the inherent low loop gain needed to prevent the integral control system from becoming unstable does not attenuate the effect of fluctuating loads upon the production system satisfactorily.

By having the plant management exhibit proportional action plus integral action, some of the desirable properties of the independent proportional and integral actions can be procured. The static performance is satisfactory, since it appears to be the same as if there were only integral action. The transient response for the production process still remains slow, but the settling time is now of the same order of magnitude as that found for the proportional control. The insensitivity of the process to cycling of the load M constitutes an improvement of the proportional-plus-integral type of action over the integral, but more improvement is needed to meet the original specifications.

The large time constant of the stock pile is the objectionable aspect of the whole system. It prevents the loop gain being set high without resultant instability. However, unusual control action can be chosen for the plant management by making the operator A contain—in addition to proportional-plus-integral action—some "undercompensated integral" and possibly some "lead" action. The additional integral effect, when inserted at the very low-frequency end of the open-loop magnitude and phase characteristic, will enable the loop gain to be increased considerably. The lead effect, which appears somewhat like anticipation, when inserted in the mid-frequency region part of the magnitude and phase characteristic, helps nullify the stock-pile lag and tends to make the production system respond somewhat more rapidly to sudden disturbances or commands. The operator A has the form

$$A = K_{pm}\,\frac{\tau_1 s + 1}{s}\,\frac{\tau_2 s + 1}{\tau_3 s + 1}\,\frac{\tau_4 s + 1}{\tau_5 s + 1} \qquad \text{.....[12]}$$

The first term in Equation [12] gives the static sensitivity of the plant management. The second term represents the combined proportional-plus-integral action. The third term, where τ_3 is greater than τ_2, represents the undercompensated integral action. The fourth term gives the lead action when τ_4 is greater than τ_5.

Graphical analysis will bear out the fact that plant-management action as described by the operator in Equation [12] will lead to performance of the closed production system within reasonable tolerance of the original specifications. It seems fair to assume that this degree of complexity of management action probably would not be recognized as being needed, had the system analysis and synthesis not been made by using servotechnique.

EXTENSION OF THE TECHNIQUE

In a paper such as this it is not possible to present a completely general treatment of linear-production-system analysis. However, the material presented does show that generalization can be attempted and that the interpretation of the results may have important influence upon the choice of organizational patterns for production processes, the design of the specific components which make up the unit processes, and the choice of controlling pattern followed by the operators—whether they be humans or robots.

A danger must be recognized in any attempt to further the work presented thus far. The analysis and synthesis of linear production systems must not be attempted by compressing all problems into the framework of servomechanisms theory or network theory. Instead, the theorems and concepts of servomechanisms theory should be used to guide the systematic and thorough study of modern industrial-production processes so that *their* unit processes can be discovered and given exact definition. The mathematical expressions for new functions may be required; new system interconnections and new rules governing their simplification may be called for; and a whole new set of criteria for judging the performance of linear production systems may be needed.

To analyze production-system dynamics without giving some attention to the problem of the economics associated with manufacturing, would be short-sighted indeed. Some of the forces which are brought to bear upon the manufacturing plants by management have their origins largely in the economic sphere rather than in the engineering or technological spheres. For example, the level of inventory that may be set for a production process may be dictated by market studies which give the prospects of future sale. Periodic alterations of the commands and reference levels set for production systems may stem not only from purely economic factors related to competition but also from economic factors that arise from hedging against sharp changes in sales caused by other factors, such as local, national, or international affairs. Labor troubles, impurities in raw materials, changes in the cost of power, sudden loss of power, technological improvements in competitive fields which force design changes, the wear and obsolescence of machinery—all these enter into the assessment of the whole dynamics problem.

Finally, despite the fact that much tedious work remains to be done before many production-system dynamics problems can be brought within quantitative study, the nature of the work makes long-range results appear worth while. Once concrete data can be procured for some of the unit processes, the analog and digital-computing-machine capacity at our disposal may prove invaluable in the systematic exploration of large-scale industrial dynamic systems. Furthermore, by means of the computational aid, many of the economic aspects of the dynamics problem can be studied simultaneously with the production by measuring the appropriate variables of the production system, and letting these quantities generate information from which the computer can determine manufacturing costs, price of product, raw-material requirements, and optimum production schedules.

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BUSINESS LEADERSHIP *in a* DEMOCRACY

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HISTORIANS are about as able a group as any to trace the course that man has followed to his present position. They tell us that the weaving of the fabric of social relationships that we call civilization does not proceed at an even pace, that there are times when the shuttle flashes back and forth across the loom with incredible speed. We are in such a time at present; the world is in a state of social flux. Mankind is on the move. Almost, one might say, mankind is in a stampede, tail up, head down, off into the wind, and where mankind will come up nobody knows.

Colonialism is on its way out. Statism seems to have a large portion of the 2400-million people on this planet in its grasp. There is an unholy zeal for warfare and for the acquisition of power. And perhaps historians at some distant time, when they will be surrounded by myriads of facts about this present age and seek to distill from these the spirit of the age, may well come up with the conclusion that this was an age in which man had a zeal for social justice, variously defined. Where does the United States stand in regard to these widespread shifts in social values?

OURS IS A BUSINESS CIVILIZATION

We have created in the United States, for good or ill, what is essentially a business civilization. There is nothing quite like it among the 65 so-called sovereign powers of the planet. Contrast the attitude toward business in Europe and the United States. Abroad, in a mixed group after dinner, conversation will concern itself with the arts, sciences, statesmanship, warfare, but not about business as such. There is talk about the national economy but not about business, as business. Business is something that is demeaning, rather petty. It is sordid, not worthy of the attention of intellectual cultured minds.

On the contrary, here in the United States, when we finish a round of golf and are in the locker room, we talk business. When the ladies go to the powder room between rubbers of bridge, the conversation of the men veers to business. It is our "meat and drink and good red wine." It occupies all of our working hours and a great deal of the time we should be devoting to recreation, in the original sense of the word.

Now, can our business civilization, as we know it, survive? Let me try to paint, with a broad brush, background for your consideration of this question. When the first settlers came to North America, they were on the richest of the five continents. Europe was fully occupied and the mass of the population was poverty-stricken. Asia, then as now, was overcrowded. South America was habitable for the white man only in limited portions; Australia was barren except for the narrow rim of fertile ground around the edge. Here in North America there was almost unlimited soil, a stimulating climate, a plentiful supply of water, timber abundant to the point of being a problem, all of the industrial minerals; the crops of Europe were suitable for cultivation here, and there were some that were peculiarly North American.

Great social forces were at work when this country was founded. When we signed the Declaration of Independence, the steam engine of James Watt had just been invented. Adam Smith, a professor of moral philosophy in a Scottish university, had recently put forth his "Wealth of Nations," setting forth the doctrine of laissez faire, contending that the government ought to stay out of the affairs of the individual man to the greatest possible extent, and that free enterprise ought to be the pivotal policy in the realm of economics.

It was an age of exploration; bold men in three-masted schooners were opening up the new lands and world population was to expand rapidly. The intellectual and spiritual impetus from the Renaissance was still at work.

Who came to the United States? By a process of natural selection a peculiar breed of men migrated to this land. They were liberty-loving, adventuresome, energetic. They were incredibly varied as to culture and social status, as to ancestry and talents. When they crossed the ocean they did not push ahead of them the ancestral wheelbarrow. They had severed their ties with the past. They came here to find freedom and opportunity. An observant, brilliant, young French historian, de Tocqueville, came over here in the 1830's, when the young nation was in swaddling clothes, to look at our brand of democracy. He went back and wrote four volumes about us and our institutions. He was especially impressed by what he regarded as an unusual talent for voluntary association.

From the outset, our growth was rapid and constant—the growth incident to subduing a continent. Two of the basic elements in our progress were free land, land to be had almost for the asking, and a scant labor supply which, because it was scant, had to be supplemented by increased use of machinery. The latter was relatively easy to accomplish because of a talent that has been referred to as Yankee ingenuity.

This age of exploration, accompanied by use of mechanical power, resulted in an expanding world population. Between 1750 and 1900 the world's population increased from 700 million to 1600 million, almost 1 billion new customers for business.

We went on, decade after decade, expanding at an incredible rate, plowing back every year 20 per cent of the gross output into the economy as plant, equipment, and inventory.

CAPTAINS OF INDUSTRY

What type of business leader emerged from these decades of rising industrialism? I shall start with the post Civil War period, from 1865 to 1900. The men who came to the fore in these turbulent times were captains of industry, men of blood and iron; their motto was: "Ask no quarter, give no quarter. When you see a head, hit it!"

These men are typed in John D. Rockefeller, the elder, Andrew Carnegie, James J. Hill, Gustavus Swift, Henry Clay Frick, and scores of others. This was the period of autocratic management, and one need not be severely critical about it because it was related to the general spirit and standards of the times.

Roy V. Wright Memorial Lecture, presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

We felt that America was destined to go on expanding indefinitely; indeed, at the turn of the century when annexation of the Philippines was being considered, we offered as a reason for annexation, the doctrine of "manifest destiny."

God in his heavens had intended that the Philippines were to come within the aegis of the United States. However, a few cynics felt that this would not be the case. Henry Adams, a scion of a distinguished family, was one of these. He sat in his well-stocked library in Lafayette Square in Washington and mused about the future of America. He said, in effect: "The physical frontier as a symbol of opportunity has now disappeared. Watch, now that America has matured, for scar tissue to form in the arterial system. Look for the degenerative diseases to set in. This nation will now slow down and go the way of all flesh."

Thus, in a sense anticipating, perhaps, Toynbee's doctrines as to how nations are conceived, born, go through lusty youth to full manhood, and then go finally into decline and senility and extinction, did Henry Adams think.

SCIENTIFIC MANAGEMENT TAKES OVER

But this did not occur. We passed from the period of autocratic business management over to the period of scientific management and continued to grow in size and strength. Who were the new leaders? I need not recount them to this Society: Towne, Taylor, Gantt, and Emerson. These men put the business enterprise under the glass and examined it carefully. They found that there were certain basic functions within the business enterprise that differed one from the other; they then turned to young industrial associates and said: "Here, stake out a claim. Go in and extract the pay dirt that is in the territory you select." Thus were functions such as production management, purchasing, accounting, corporate finance, personnel administration developed.

We substituted for old rule-of-thumb methods, carefully worked out, rational, inductive techniques of industrial management. Such management, plus fuller use of science and its handmaiden, technology, meant that when we turned into the present century, growth continued at the same rate, roughly 2½ per cent a year cumulatively. It looked as though we were about to solve all our problems. Then the Great Depression of the '30's hit us.

The economic engine stalled, we adjusted the carburetor, altered the points, changed the fuel, tried new lubricants; the engine would turn over a couple of times, then sputter and stop. Here was a national dilemma. The richest of the continents—with 130 million business-minded, energetic, intelligent people—was unable to bring together natural resources and human resources so as to maintain continuous, high-level employment. It was as though Karl Marx's dictum was to come to pass: "Capitalism will fail eventually because the machinery will wrack itself to pieces."

I recall a young communist graduate student, a girl from California, who argued to this effect one day in the 1930's, when it was allowable to do that sort of thing. I said, "Well, why, then, be in such a bother about it? If this is inevitable, why not go to the sidelines, take a good seat, and enjoy the show?"

DEPRESSION FOSTERS LABOR MOVEMENT

An interesting and significant development occurred in the mid-depression years. During NRA days, labor leaders decided that they would unionize the mass-production industries; enroll the rank-and-file workers. Up to that time, only 3,000,000 members had been enrolled at any one time in trade unions in the United States. Thus the modern labor movement, which began roughly in 1885, required 50 years to obtain its first 3,000,000 members. Those who joined were the aristocrats of the labor force—bricklayers, plumbers, carpenters, engineers, brakemen, and other highly skilled workmen. But after the CIO was established, the movement expanded rapidly—aided first by legislation and then by World War II. The wartime impetus arose from the need to deal with the workers collectively, if the full output of the economy were to be obtained. When World War II came to a close, the entire group of unionized workers—AFL, CIO, the Brotherhoods, and others—numbered 16,000,000 individuals. This is at present the estimated union membership of the country.

The period from 1935 to 1952 may be termed the period of management by negotiation. Thus we have passed from the period of autocratic management to the period of scientific management and on to the period of collective bargaining, or management by negotiation.

If this is a correct conclusion, then, we have arrived at what Sumner Slichter, a Harvard professor of economics and a competent observer, has called "a laboristic economy." Professor Slichter's label seems to me to be an accurate one. There is little evidence to indicate that collective bargaining will not be a permanent and major characteristic of the method by which management and workers deal with each other.

Another characteristic of our economy for an indefinite period in the future will be a heavy diversion of output of the economic machine over to purposes of war and preparedness for war. These expenditures, unless fully matched by taxes, will create government deficits and a constant long-run bias toward inflation.

Under conditions just outlined, all the major groups involved—trade unions, management, government (legislative and administrative), as well as the common citizen—must make unusual efforts to exercise self-discipline. It is difficult to curb governmental expenditures, to impose necessary taxes, to refrain from using coercive measures to impose wage demands, to lower prices and forego profits, to save and not spend. The basic problems of a democracy are moral ones. To repeat, they are ones of self-discipline.

DEMOCRATIC MANAGEMENT IN BUSINESS

This leads me to ask whether it is starry-eyed for us to look forward to the prospect of a new period of business management—one that can be termed democratic management. Let me explore this—first in terms of the individual; then in terms of the group.

Does business make the most of its opportunities to develop the individual? Frequently, it is asserted that the average rank-and-file worker is not intelligent enough as an individual to play an important part in the operation of the business enterprise. A working definition of intelligence is capacity to solve problems. There is evidence that intelligence usually is specific, rarely general; that is to say, one can have mathematical intelligence, mechanical intelligence, aesthetic intelligence, social intelligence of a high sort, and be relatively mediocre in the other areas. It is only when nature produces a person with a high order of intelligence in all these fields that we get a Thomas Jefferson or a Benjamin Franklin. There is in each person, I suspect, some talents that are much more highly developed than others. A business enterprise, if it is to develop the individual to the utmost, is confronted with the task of finding out what these are and then maximizing these and minimizing the limitations in the day-to-day work of the individual.

Let me state the problem differently. There are 168 hours in the week. I spend one hour in formal devotion in church. I spend 40 hours at the bank. I probably spend another 40 hours thinking about the bank. It is on the business front, if I am going to go over the top in my spiritual relations with my fellow man, that the greatest opportunities lie. I am not now

minimizing the one hour spent in church, but, too frequently, we develop what someone has referred to as a balcony attitude. If my salvation, spiritually, depends on my relations with my fellow men, it is on the business front that I have the greatest opportunity to achieve results.

In terms of the group, there are in the United States two types of groups of primary importance: The family and the business enterprise. There are 40,000,000 families at the present time in this country, and roughly 4,000,000 business enterprises. As a social building block, there is no greater unit than the family—husband and wife, and the children, against the world; at its best, presenting a solid front, handling problems resourcefully, concealing limitations of inheritance and social status, and bringing to full flower the Christian graces of forebearance, affection, mutual assistance, and love!

BUSINESS—A SOCIAL ORGANISM

The business enterprise likewise can become a social building block. It is a social organism in which each part has its essential role and where the whole is greater than the parts. Indeed, some of the foremost thinkers in the field of how man is going to be able to live with man, an art that is now at low ebb, have said that the business enterprise is an intricate web of human relations bound together by a system of sentiments. What are the sentiments but customs, traditions, routines, feelings, duties, rights, ranks, status?

If American business management with its customary vigor and resourcefulness will go to work to make business not only a means to a livelihood but a way of life, we can well imagine what would happen. Let me illustrate. In the complex, intricate life of our institution, the Federal Reserve Bank of Philadelphia, with its 1250 employees, there are talents unused, that have only to be called upon to give to the individual possessing them a sense of participation. The point may be illustrated in this way. During the flower-growing season, we have in the foyer of the bank an illuminated shadow box in which we display flowers grown by some member of the bank family. There is a committee on flower arrangements. I discovered, to my embarrassment, that the chairman of the committee, the chief telephone operator, had spent hundreds of dollars of her own money for figurines and vases and silks and that she, with consummate skill, not only arranged flowers but helped to train other girls to arrange them. On this one tiny facet of the intricate life of our large institution, she is my leader and I am her follower.

How does one go about preparing to enrich the personal life of the individual in business? There is, I think, an art that is emerging. To start at the top: I cite what seemed to me to be four basic elements in training top leadership in a democratic business civilization of the sort I am envisioning. I put first, technical competence; the necessity for every leader to have an understanding and a mastery of his special field—engineering, merchandising, accounting, finance, or personnel. Each field of American business is becoming increasingly technical and requires technical training. The mastery of a given field brings rich rewards. It stirs men to the innermost core of their being. To have a deep and thorough knowledge of a field—bridge building, heart surgery, newspaper publishing, railroad operation, or any field that is germane to the welfare of mankind—is to give its possessor unusual opportunity to serve his fellow man.

The second basic element I would state as broad intellectual interests. I am not now thinking about formal training in college where perhaps most of the time has to be given over to technical education, but am thinking of self-training for which there are ample opportunities afterwards. The point is illustrated by knowledge of history. History gives a comprehension of social change, a sense of continuity; it, therefore, provides stability and gives one a tie to the past. It gives a feeling for trends; it builds up a protection against panic arising from short-run changes.

I am thinking of a knowledge of foreign relations. The businessman of the future cannot afford to be provincial in his outlook. An insight into the nature of other governments will broaden one's views, make one's prejudices more malleable. It will aid us in living with the rest of the world.

A knowledge of literature should be included. In my years in business and in education, I have been impressed with the number of men of affairs who have increased their knowledge of life by means of literature. If it is good literature, it gives sound insight into motives—vicarious knowledge. An exposition of life from the pen of a master supplies fruitful analogies, furnishes spiritual insight and understanding, just as knowledge of other governments gives an awareness of other modes of living than our own. A basis for comparison is provided which makes for breadth of view.

A third aspect is social intelligence. This may be defined as a capacity to understand and deal with men, especially in groups. How frequently have we seen a man skilled in person-to-person relationships, when placed before a trade association, or a professional organization, or a labor union, or an investigating committee of Congress, lose much of his skill. Here, we have made scant beginnings, but there are great opportunities ahead.

The art of handling men in groups is now undergoing study and experiment with a view to developing a clear-cut definition of problems, fruitful conduct of discussion, constructive compromise of differences, well-defined channels of communication, and greater knowledge of the nature of group action—its origin, development, and pathology. These are results that we should regard as necessary if we are to deal effectively with men in groups such as trade unions, trade associations, legislatures, and corporations.

Finally, a fourth aspect of top leadership is a well-knit set of ethical, moral, and spiritual values. These values set up a central drive, within the individual, of respect for the personality and worth of the other man. If this is attained, there follows an integration of various loyalties—many of them conflicting—and an inner poise and strength so necessary in these days of social tension, frustration, and seeming defeat. Such poise and strength are the most difficult of all attainments. My personal conviction is that it rests basically on a spiritual desire to aid in the development of one's fellow man.

REDISCOVERING THE INDIVIDUAL

If the zeal of the present age is for social justice, if the entire planet is in a state of social flux, where will our particular brand of zeal for social justice lead the United States? There is a danger that, with our rich natural resources and our highly developed technology, we may come to regard materialism as a value per se. There is a dictum in economics to this effect: The wants of man, satisfied, tend indefinitely to expand. In this country we have an unusual capacity to satisfy our physical wants. Individual men, bound together in groups for action, need to be led by men broadly based as to both intellectual and spiritual values. Will the group ask for too much, too soon? Will the group want the wrong things? Will opposing groups yield too little, too late? Democracy has been referred to as a hard core of agreement surrounded by a bewildering diversity of values and objectives. I submit for your consideration the thought that the hard core of value in American life should be the "individual."

Karl Marx said that when communism comes to full flower, the individual will disappear in the state. What a horrible

(*Continued on page 306*)

ASARCO CONTINUOUS-CAST BEARING BRONZES

By J. S. SMART, JR.,[1] and PAUL J. KRANZ[2]

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DURING 1952 the Asarco continuous-casting process[3,4] will have completed 15 years of commercial service. Within this short period, the continuous casting of nonferrous metals in the United States has progressed from the development stage to a remarkable degree of commercial success, and in fact, to applications which would have looked forbiddingly complex so recently as five years ago. This has been accomplished by the multiple but individualistic type of approach of competitive enterprise, which when confronted by a variety of conditions peculiar to the requirements of the copper, brass, aluminum, and magnesium industries, worked out new solutions at home, imported others from abroad, and by now has established commercially at least seven processes, each of which is peculiarly suited to its specialized task.

Such recent rapid strides in a field so difficult that practical realization of the original basic proposal required some 75 years, are ample evidence of the fact that continuous casting offers highly important advantages which are not achieved by conventional techniques. From the point of view of the consumer, one of the most significant of these is the transformation of the casting scheme from an aggregate of a large number of small batch operations, each of which can vary with regard to quality criteria, to a closely controlled continuous operation which produces castings of greatly improved quality with a degree of uniformity never attainable by batch methods.

Quite logically, these and other related possibilities resulted initially in the adaptation of the new techniques to the production of castings for mill fabrication, where a large tonnage demand is concentrated in a minimum number of different shapes of large cross section. The advantages to the mills of such improvements in both operating technique and quality of basic castings are significant, but by the very nature of fabricating processes, the mills always have had considerable opportunity for the recognition and elimination of defective castings during the heavy working operations to which they are subjected. On the other hand, foundry products intended for use as castings, are normally in the hands of the customer, and are often fully machined before being rejected for hidden casting defects. Consequently, the advent of a casting process which virtually assures freedom from such internal defects as porosity and shrinkage is extraordinarily beneficial to the consumer of foundry products.

However, the successful application of continuous casting to this field is exceedingly complex, by comparison, since the foundry market requires a tremendous variety of shapes and sizes to be produced in relatively small quantities. To date the Asarco process is the only method with sufficient versatility to have achieved commercial status, and it has now completed three years of pilot-plant and five years of full operation in a plant specifically designed for the manufacture of tin-bronze-alloy products including the compositions normally employed for bearings, bushings, and structural parts.

Fig. 1 illustrates the operating principles of the casting equipment. The furnace is of welded steel construction, heavily lined with insulating brick, and electrically heated by graphite resistors in order to provide constant temperature conditions. The metal supply is furnished by batch-melting of accurately weighed charges in an adjacent electric furnace. After pouring into the rectangular graphite casting crucible where deoxidation is effected, the metal flows into the die chamber by gravity, and finally into the graphite-die and cooling-jacket assembly, where it is solidified and withdrawn at a constant rate by a roll drive mounted below the furnace, ahead of the cutoff saw.

Unusual flexibility of operation is provided by construction of dies and jackets as separate units. Jackets are built as permanent items of equipment in a number of standard sizes. Dies are expendable, having an average life of 24 hours, and are relatively inexpensive. Consequently, special sizes and shapes, and small-quantity production runs are commercially practical.

Using multiple-hole die techniques for the smaller sizes, rods can be cast to any dimension between $^{7}/_{16}$ and $5^{1}/_{8}$ in. Tube sizes start at 1 in. OD with a minimum wall thickness of $^{3}/_{16}$ in. Special shapes include octagons, hexagons, and squares, either solid or cored, and rectangles. Although these products are cast to size, and straightening is the only finishing operation, dimensional control is excellent and the mill lengths produced are ideally suited to screw-machine use.

It is a basic tenet of continuous casting that solidification must be accomplished with great rapidity. However, the turbulence caused by feeding a stream of metal into a highly chilled mold is incompatible with the formation of a good surface. Furthermore, such streams cannot be maintained successfully and regulated when casting small sections. In the Asarco process the circumvention of these problems is accomplished by the use of a true bottom-casting technique in which the top of the die projects into the molten-metal reservoir. This basic principle provides self-contained and automatic metal feed, avoids turbulence, and furnishes an ideal all-liquid riser, which eliminates shrinkage defects completely, and serves as an escape path for evolved gases. These very favorable casting conditions are further enhanced by the fact that graphite is self-lubricating, and requires no insulating dressing to prevent wetting, with the result that rate of chill is exceptional, and a very shallow freezing zone is maintained at all times.

PHYSICAL PROPERTIES

In the case of a pure metal such as copper, the application of such a casting scheme results in products which are physically superior to those made by other methods, but the differences

[1] Superintendent of Copper Developments.

[2] Research Investigator, Research Department.

[3] "Continuous Casting—The Asarco Process," by J. S. Smart, Jr., and A. A. Smith, Jr., *Iron Age*, vol. 162, August 26, 1948, pp. 72–80.

[4] "Asarco Continuous Cast Shapes—Their Manufacture and Use," by J. S. Smart, Jr., and A. A. Smith, Jr., *Iron Age*, vol. 164, September 22, 1949, pp. 67–72.

Contributed by the Metals Engineering Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1952, of The American Society of Mechanical Engineers.

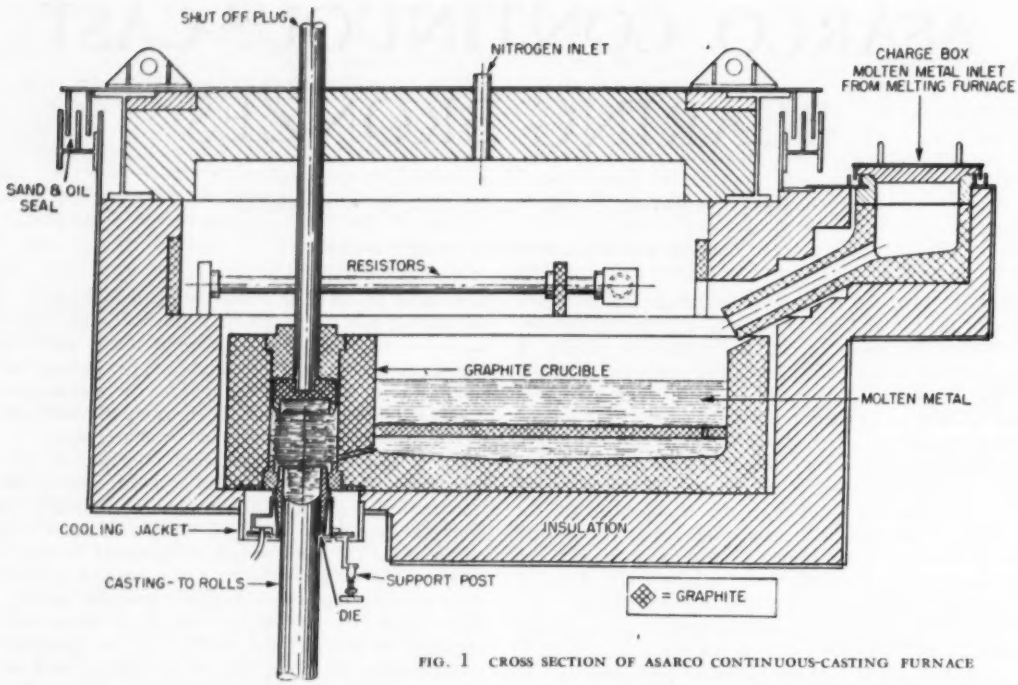


FIG. 1 CROSS SECTION OF ASARCO CONTINUOUS-CASTING FURNACE

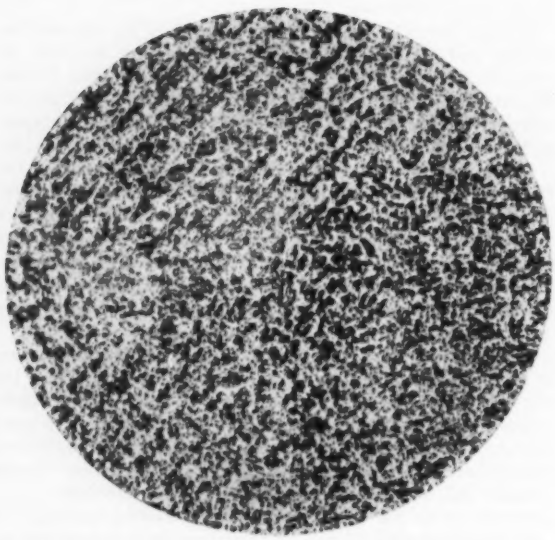


FIG. 2 MICROSTRUCTURE OF CONTINUOUS-CAST 75-5-20-0; ×100

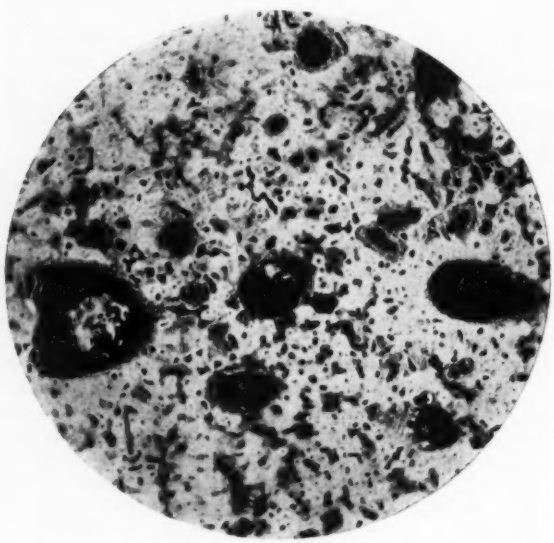


FIG. 3 MICROSTRUCTURE OF COMMERCIALLY SAND-CAST 20 PER CENT LEAD BEARING BRONZE; ×100

in metallurgical structure may be quite minor. Bronze alloys are much more complex and very beneficial results can be achieved by control of the dispersion of the tin-rich and globular lead secondary phases which they contain. Many attempts have been made to secure the desired fine uniform structures by alloying additions, special fluxes, and the like, but such measures are almost insignificant when compared to the effects of high rates of chill.

Figs. 2 and 3 compare the typical structures obtained by continuous-casting and sand-casting a high-leaded bearing bronze. The striking difference in this case is due to greatly improved dispersion of lead, but the same general effect is obtained with the tin-rich delta phase. This basic modification of microstructure presents visible evidence of two notable results; the quality of such castings is much more uniform than those produced by normal foundry practice, and the physical properties are exceptionally high.

Tables 1 and 2 summarize the data obtained to date from an investigation of the properties of typical continuous castings made in the course of commercial production of a variety of alloys widely used for bearings, bushings, and other related

TABLE 1 PHYSICAL PROPERTIES OF LEADED BEARING BRONZES

Nominal composition	85-5-5-5		85-5-9-1		83-7-7-3		84-8-8-0		80-10-10-0		75-5-20-0	
SAE No.	40		66		660		None		64		None	
Casting method	Contin. cast	Sand cast	Contin. cast	Sand cast	Contin. cast	Sand cast	Contin. cast	Sand cast	Contin. cast	Sand cast	Contin. cast	Sand cast
Tensile strength, psi	45000	36400	39000	32000	44000	40400	43000		39000	35000	30000	26900
Yield strength, psi	21400	16900	18000	16000	27000	19500	24000		25000	17000	18000	15800
Elongation, per cent in 2 in.	28	35	34	18	16	39	22		10	15	13	17
Rockwell hardness, B scale	43		32		46		46		48		16	
Brinell hardness, 500 kg	72	49	65	62	72	65	74		74	65	57	45
Impact strength, ft-lb	20.7	12.0	13.0		12.5	9.3	13.0		6.0	4.5	6.2	5.5
Endurance limit, psi	16000	8500			20000	12000			22500	16000	16000	12500

Notes: Nominal compositions given in following order: Cu-Sn-Pb-Zn-Ni. Endurance limits at 20×10^6 cycles. Impact tests in accordance with ASTM E23-41T Type Z.

TABLE 2 PHYSICAL PROPERTIES OF NONLEADED AND LOW-LEAD BRONZES

Nominal composition	89-11-0-0		88-10-0-2		88-8-0-4		88-10-2-0		84-10-2.5-0-3.5		88-6-1.5-4.5	
SAE No.	65		62		620		63				622	
Casting method	Contin. cast	Sand cast	Contin. cast	Sand cast	Contin. cast	Sand cast	Contin. cast	Sand cast	Contin. cast	Sand cast	Contin. cast	Sand cast
Tensile strength, psi	55000		53000	50000	51000	48000	49000		59000		45000	39000
Yield strength, psi	26500		25000	20000	22000	18000	23000		34000		23000	18000
Elongation, per cent in 2 in.	26		30	25	52	45	29		15		40	35
Rockwell hardness, B scale	59		57		51		57		65		50	
Brinell hardness, 500 kg	86		86	76	74	72	80		89		72	70
Impact strength, ft-lb	35.0		25.5	8.7	22.0		11.0		14.0		28	
Endurance limit, psi			24500	13000			21800		24800			

parts. Wherever possible, samples were taken from $1^1/_8$-in-diam stock, but it was found necessary in a few cases to employ material having a diameter range of $^7/_8$ to $1^1/_2$ in. All tests were performed by accepted ASTM procedures on machined test bars. Also given, for purposes of comparison, are values obtained from sand castings for a number of the same compositions. It should be recognized that these data are individual in nature, and do not represent average values; hence comparisons are indicative, but certainly not absolute.

Despite the possibility of some variation between one lot of castings and another, these test results demonstrate quite clearly the effects of different rates of chill. Compared to sand castings, continuous castings have high strength and high hardness (which are usually but not always accompanied by somewhat lower elongation values), as well as greatly improved fatigue and impact properties. Special mention also should be made of the very considerable increases in yield strength which are obtained.

All of these benefits are of practical use in meeting severe bearing and bushing service requirements. Operating experience with a wide variety of applications in aircraft diesel and automotive engines over a period of eight years has demonstrated fully the value of these improvements.

The problem of fatigue failures in such applications is often of special significance. Castings which are free from porosity and shrinkage defects possess particular advantages since flaws of this nature act as notches, or stress raisers, which lower the endurance limit appreciably. The addition of a small quantity of lead to improve the machinability of a high-tin bronze also lowers the fatigue strength, as can be observed by comparing the values obtained from 88-10-0-2 and 88-10-2-0 in Table 2. This loss can be recovered by the addition of 3.5 per cent Ni to the alloy, modifying its composition to 84-10-2.5-0-3.5.

DRY WEAR TESTS

Owing to the higher hardness of continuous-cast bronzes as compared to those produced by other casting methods it is proper that some consideration be given to the possibility that such modifications might lead to injurious effects such as scoring or galling. While eight years of actual use has not revealed any indications of this possibility, a program of dry wear testing has been employed to gain additional information. Dry wear tests are empirical in nature, and are difficult to interpret, but have been considered to offer some help in the selection of alloys for final evaluation under service conditions. It is almost universally agreed that there is no substitute for actual service tests owing to the complexity of the combination of factors which determine wear.[5]

The testing equipment used is of original design, Fig. 4, and was constructed both because of its simplicity and its ability to employ a type of specimen that could be obtained readily from the products under consideration. In principle, a machined bronze sample, having a wearing surface in the form of an annular ring, Fig. 5, is rotated against a base material which is mounted in a holder fastened to the base plate. The base material is normally hardened steel, ground to a controlled finish, but other materials can be substituted as desired. The load on the specimen is the sum of the weight of the shaft, and the dead load applied through a lever arm which bears at diametrically opposite points on the outer race of a ball bearing, the inner race being supported by a collar mounted on the shaft. This assembly can be calibrated by direct weighing while in motion; weight of the variable drive is carried independently.

Investigation of the characteristics of the equipment has indicated that different speeds of rotation between limits of 450 to 1000 rpm yield identical wear rates in terms of equal total distance traveled by the specimen. Variations in load between 25 and 100 psi also affect wear by a linear relation. Accordingly the following standard test conditions were established for dry wear:

Bronze specimen:

Width of wearing surface, in.	0.0625
Area of wearing surface, sq in.	0.184
Circumference (mean), ft	0.294

Base material:

SAE 4140 steel, Rockwell C 50, Bhn 477 (3000 Kg) ground to 6 microinches rms finish

Test conditions:

Speed, fpm 137 Load, psi 50 Lubricant none

[5] Proceedings of Special Summer Conference on Friction and Surface Finish, Massachusetts Institute of Technology, 1940.

In operation, tests are conducted for periods of time of from 1 to 8 hours in order to accumulate appreciable total wear. Losses of specimen thickness are measured by means of micrometers, and a wear-rate index calculated which is expressed as the number of thousandths of an inch of wear in a period of one hour. Total wear plotted against total time at hourly intervals normally results in a linear relationship of good reproducibility. Representative data obtained are listed in Table 3.

TABLE 3 DRY WEAR TESTS ON CONTINUOUS-CAST BRONZES

Nominal composition					Wear rate,
Cu	Sn	Pb	Zn	Ni	0.001 iph
89	11	0	0		Nil
88	10	0	2		4
80	10	10			13
75	5	20			15
75	10	15			18
83	7	7	3		21
82	5	13			22
85	5	5	5		43
84	10	2.5	0	3.5	46
88	10	2	0		49
88	4	4	4		55
88	6	1.5	4.5		95

In the opinion of the authors these results are useful primarily to indicate that certain differences in behavior exist between various alloys in order that such factors can be given consideration when conducting service tests. For instance, in order to obtain high resistance to dry wear, a nonleaded high-tin bronze such as 88-10-0-2 or 89-11 should certainly be considered. Obviously also, if dry wear resistance is essential, the use of an alloy containing a small amount of lead (1.5 to 2.5 per cent) to improve machinability should be investigated critically since the possibility exists that small amounts of lead lower dry wear resistance appreciably. Higher amounts of lead, such as are found in true leaded bearing bronzes, are apparently more desirable.

Table 4 presents some additional results obtained from a number of other materials, including several bearing bronzes cast by conventional foundry methods which were purchased from commercial stocks. The nominal analyses given for the bronzes were determined chemically. Their dry wear ratings are essentially similar to those obtained from continuous-cast materials of similar composition. As in the case of bronzes, the two brass alloys exhibit large differences in wear rate owing to the presence of a small amount of lead.

Of all the materials tested, only 89-11 bronze, naval brass, and the tin-base babbitt caused wear of the steel base. In each case the specimen acquired a shiny black surface film, which, in effect, became the wearing surface. This serves to illustrate the complexity of conditions existing in such tests, since cutting, abrasion, molecular welding of the dissimilar metals at the interface, and the formation of oxides, or other films which separate the clean metal surfaces, may all occur simultaneously.

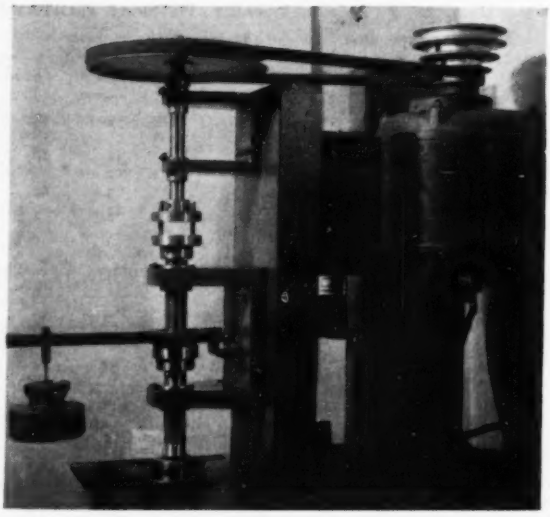


FIG. 4 DRY WEAR TESTING MACHINE

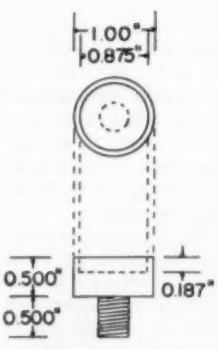


FIG. 5 BRONZE WEAR-TEST SPECIMEN

True dry wear is rarely encountered in actual service owing to the presence of some amount of lubricant. In the presence of full fluid-film lubrication, no wear results. When lubricating conditions become less than optimum, the only applicable test is a service test. Nothing better illustrates the foolhardiness of applying dry wear test results to lubricated conditions than the data given in Table 4 for two babbitt alloys of universally accepted worth as bearing metals. The tin-base babbitt might have been rated as unsuitable because it scored the hardened-steel base; the lead-base babbitt might have been considered useless because of excessive wear rate. Thus in this case the test results are mainly indicative of the ability of the bearing metals to form oxidized protective surface films, and no correlation with their performance in the presence of a lubricating film exists.

TABLE 4 DRY WEAR TESTS ON OTHER COMMERCIAL ALLOYS

Nominal composition							Wear rate,
Cu	Sn	Pb	Zn	Ni	Sb	Identification	0.001 iph
60	0.75	0	39.25	0	0	Naval brass	2
62	0	3.25	34.75	0	0	Free-cutting brass	71
80.5	6.5	10.5	2.5			Bronze-bearing alloy	16
83	7	7	3			Bronze-bearing alloy	17
81	8	9	2			Bronze-bearing alloy	19
83	7	8.5	1.5			Bronze-bearing alloy	22
30	(1.5 Fe)	(1 Mn)		67		Monel	25
3.5	89				7.5	Tin-base babbitt, SAE 110	Nil
0	1	83	(1 As)		15	S-babbitt SAE 15	100

CONCLUSIONS

1 Continuous-casting of the standard bronze compositions normally employed for bearings, bushings, and structural uses results in beneficial increases in physical properties. These improvements result primarily from high rate of chill and freedom from casting flaws.

2 The dry wear characteristics of bronzes cast by the Asarco process are essentially similar to those produced by conventional methods.

Dry wear tests are no criterion of the ability of bearing alloys to perform satisfactorily under service conditions involving lubrication.

PROGRESS *in* RAILWAY MECHANICAL ENGINEERING[1]

1951–1952

DIESELS EXCEED STEAM LOCOMOTIVES

ANOTHER milestone in the eventually predominant dieselization of American railroads was passed during the year covered by this review of progress in railway mechanical engineering. As of June 1, 1952, domestic railroads owned 19,082 diesel-electric motive-power units in comparison with 18,489 steam locomotives, thus marking the first time that ownership of the former type has exceeded that of the latter. The rate at which the steam locomotive is being replaced by the diesel is shown by the following later statistics.

LOCOMOTIVES OWNED OR LEASED—USA CLASS I RAILROADS

Type	As of Aug. 1, 1952	Aug. 1, 1951	Change
Steam	17693	23469	−5776
Diesel (units)	19488	16231	+3257

While eventual saturation and a slowing down of new diesel-unit production seems inevitable, current production figures and those projected for the next few years indicate that the "knee" of the saturation curve is still several years in the future. Contrary to general expectations that the replacement of steam power by diesels would slow down, once the "cream" of applications had been skimmed, the range of diesel-electric applications continues to extend as operating personnel and management become more familiar through actual experience with the versatility of this type of power.

Electric drive continues its predominant position in American diesel locomotives, and there seems to be small likelihood that other types of drive will offer appreciable competition in domestic railroading, particularly in road service, for some time to come. European designers, however, and particularly the Germans, have extended the application of combination mechanical-hydraulic drives into the intermediate horsepower area, whereas heretofore the applications have been largely restricted to the lower horsepower ratings. The "Mekydro" transmission, described elsewhere in this report in connection with its use in a German-built locomotive, is available for single-engine applications up to 1000 hp.

The use of mechanical and hydraulic drives in rail motive power in the United States to date, has been restricted to low-powered rail cars and to switching locomotives of the industrial type, generally of 40 tons or less in weight. Experimental models, employing hydraulic torque-converter drive and weighing 65 tons or so, have been built by various builders with varying success, but as yet have not been offered for general commercial applications. Improvements in torque-converter designs and their associated transmission gearing may extend the use of nonelectric drives to heavier more powerful railroad switching units, at least, in the not-too-distant future.

European designers have succeeded in producing "quick-running," or high-speed, engines with low specific weights in units of relatively high horsepower ratings, compared to those available in the United States domestic field for railroad application. Engines rating 650 to 1200 hp in the 1400 to 1600-rpm speed range are being employed in Continental diesel-locomotive and rail-car applications. Illustrative of the trend to higher speeds and lower specific weight is the Maybach 1200-hp engine, running at 1600 rpm with a piston speed of 2100 fpm (1).[2]

While the diesel engine appears to have definitely "arrived" as the foremost type of prime mover for railroad use, its position as "The Champ" is assailable by other forms, particularly by the turbine. Proponents of the turbine point out that the reciprocating-piston steam engine has succumbed largely to the steam turbine in the fields of stationary power plants and ship propulsion, and that the piston engine is being hard-pressed by the turbine-jet in airplane propulsion. Accordingly the battle of the "piston versus the spinning blade" is being pressed by the proponents of oil-burning and coal-burning gas turbines and by advocates of the steam turbine. Heavily influencing this struggle is that of fuel economics and availability. Research and experimentation continue, aimed at the burning of the heavier lower-cost oils in diesel engines. Substantial success along these lines would tend to consolidate the diesel's current advantageous position and lower its vulnerability to replacement by other contending prime movers.

DIESEL LOCOMOTIVES

American builders, during the past year, have concentrated largely on quantity production of semifrozen designs for domestic railroad use. The exceptions to this general statement are the two 6-axle 6-motored designs of general-purpose locomotives brought out by Electro-Motive Division of General Motors. One design was developed for the Army Transportation Corps, on its insistence for a 1600-hp unit with relatively low axle loading for use in those theaters of potential war, where axle loading might be a critical matter. This particular design is adaptable to gage change for so-called "wide" gages of the world ranging from the standard 56½ in. to the maximum of 66 in. characteristic of the Spanish standard wide gage, with intermediate gages of 60 in. and 63 in. also being taken into account. An illustration of one of these locomotives is shown in Fig. 1, and particulars are given under item 1 of Table 1.

The 6-motored design for domestic railroads, developed by Electro-Motive, ranges in weight from 150 tons to 180 tons, and is largely a design to match similar 6-motored units brought out by other American builders during the past 2 or 3 years. This unit is shown in Fig. 2, and described under item 2 of Table 1.

Fig. 3 illustrates a 1500-hp A1A-A1A diesel-electric developed by Electro-Motive for service on the Commonwealth Railways of Australia. The design was developed especially for the flat high-speed service in the 1100 miles between Port Pirie,

[1] Report of Committee RR-6, Survey; Chairman, T. F. Perkinson; members, F. A. Benger, R. M. Coultas, R. P. Johnson, and F. L. Murphy.

Contributed by the Railroad Division and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] Numbers in parentheses refer to Bibliography at end of paper.

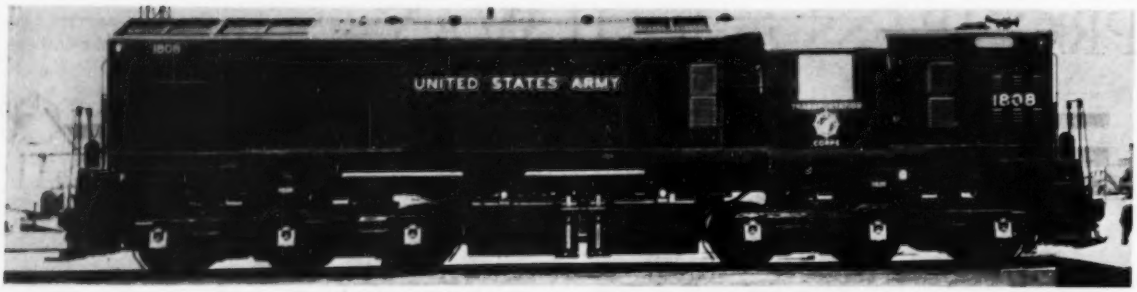


FIG. 1 1600-HP C-C DIESEL-ELECTRIC FOR U.S. ARMY TRANSPORTATION CORPS

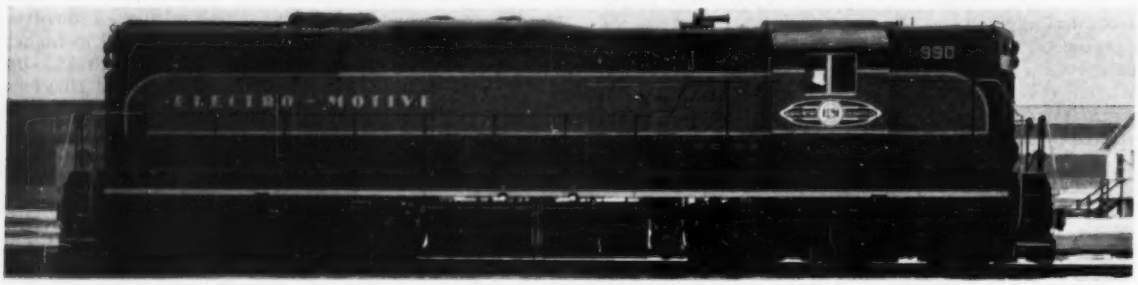


FIG. 2 GENERAL-PURPOSE 1500-HP DIESEL-ELECTRIC

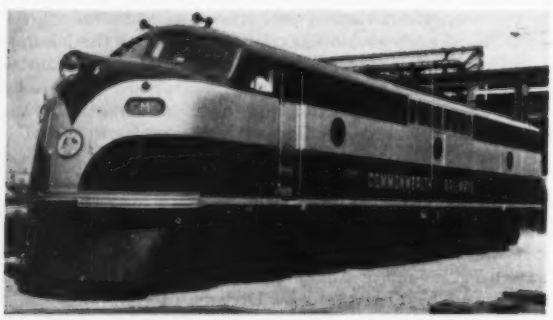


FIG. 3 A1A-A1A 1500-HP PASSENGER-FREIGHT UNIT FOR AUSTRALIA

South Australia, and Kalgoorlie, West Australia, where the longest tangent track in the world (300 miles) is encountered. Because a portion of the run is through a desert region, provision is made for supplying air to the engine room through a dust collector, which in effect slightly pressurizes the engine room. Axle-loading limitations necessitate the use of the A1A-A1A wheel arrangement. Details are carried under item 3 of Table 1.

A double-ended 1500-hp diesel-electric carried on a C-C wheel arrangement manufactured to Electro-Motive designs but built in Australia, utilizing EMD engine and electrical equipment, is shown in Fig. 4, and described under item 4 of Table 1. The 63-in-gage trucks are of welded-fabricated construction—a design which permits the Clyde Engineering Company of Australia to reduce the import content of the locomotive

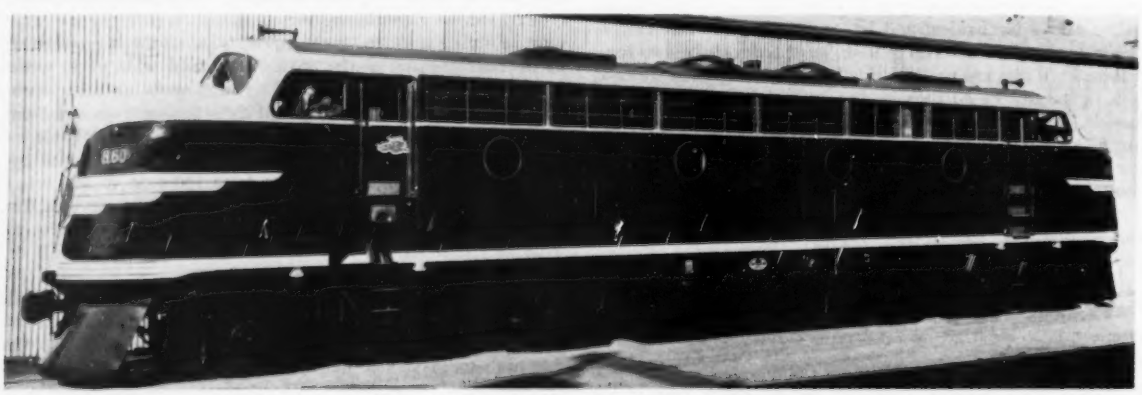


FIG. 4 DOUBLE-ENDED C-C 1500-HP UNIT WITH FABRICATED TRUCKS

TABLE 1 DEISEL LOCOMOTIVES

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
Builder	Gen. Motors	Gen. Motors	Clyde[d]	Clyde	Krauss-Maffei	French Rwys	So. Australian Rwys	Gen. Electric	Davenport[g]	Gen. Electric
Owner	U. S. Army	Various RRs	Australia[e]	Australia[f]	German Rwys	French Rwys	So. Australian Rwys	Uruguay Rwys	Rhodesia Rwys	Queensland Rwys
Wheel arrangement	C-C	C-C	AIA-AIA	C-C	B-B	C	AIA-AIA	C-C	C-C	C-C
Service[a]	P, F, S	P, F, S	P, F	P, F	P, F, S	S	P, F	F	P, F	F
Engine data:										
Engines per cab	1	1	1	1	1	1	1	1	2	1
Engine hp rating	1600	1500	1500	1500	1000	380	1760	1400	500	1100
No. of cylinders	16(Vee)	16(Vee)	16(Vee)	16(Vee)	12(Vee)	12(Vee)	16(Vee)	12(Vee)	12(Vee)	12(Vee)
Bore and stroke, in.	$8^1/_2 \times 10$	$8^1/_2 \times 10$	$8^1/_2 \times 10$	$8^1/_2 \times 10$	—	$5^1/_2 \times 6^3/_4$	10×12	$9 \times 10^1/_2$	$5^3/_4 \times 8$	$9 \times 10^1/_2$
Engine speed, rpm	800	800	800	800	—	1500	750	1000	1200	1000
Cycles	2	2	2	2	—	4	4	4	4	4
Supercharged	No	No	No	No	Yes	—	Yes	Yes	No	Yes
Manufacturer	Gen. Motors	Gen. Motors	Gen. Motors	Gen. Motors	Maybach	Renault	English Elec	American Loco	Caterpillar	C-B[h]
Weight on drivers, lb	41000	50-60000	42600	42500	132000	119000	179000	224000	173260	197400
Total locomotive weight, lb	246000[b]	300-360000	244000	255000	132000	119000	269000	224000	173260	197400
Fuel capacity, gal	800	1200	1800	1200	440	260	1000	1000	650	900
Driving wheel diam, in.	40	40	40	40	37	55	42	40	36	36
Type of drive	Electric	Electric	Electric	Electric	Torque-conv	Hydraulic	Electric	Electric	Electric	Electric
Track gage, in.	$56^1/_2$[c]	$56^1/_2$	$56^1/_2$	63	$56^1/_2$	$56^1/_2$	63	$56^1/_2$	42	42
Maximum permissible speed, mph	77	55-89	89	83	62	37	70	60	55	50

[a] P = Passenger; F = freight; S = switching.
[b] Includes train-heating boiler.
[c] Adjustable to any broader gage.
[d] Clyde Industries Limited, Australia.
[e] Commonwealth Railways.
[f] Victorian Railways.
[g] Davenport Besler Corp.
[h] Cooper-Bessemer Corp.

14 per cent under that of a unit equipped with imported cast-steel truck frames.

An interesting and novel design of diesel locomotive is the 1000-hp general-purpose unit illustrated in Figs. 5, 6, and 7, and detailed under item 5 of Table 1. The 1600-rpm diesel engine is coupled through a hydraulic coupling and a Mekydro four-speed mechanical gear change to a centrally located transmission, from which universal-jointed, telescoping drive shafts lead to gearboxes located in each of the two 2-axle swivel trucks. Each axle is driven through a short universal-jointed shaft from the associated truck-mounted gearbox. In Fig. 7, is illustrated the lever-and-pin arrangement which is used in lieu of a fixed truck center plate. The cab weight is carried to each truck through four spring-loading pads as shown. The locomotive fully loaded weighs approximately 70 tons.

The Mekydro transmission, Fig. 8, is a combination of mechanically clutched gearing and hydraulic coupling, automatically controlled as regards gear changes, by the locomotive and engine speeds. The hydraulic coupling also contains the reversing gear. Gear changing is accomplished with minimized shock by specially shaped clutch profiles, and by automatic disengagement of the hydraulic coupling during the gear-clutching operation.

With the object of standardizing on switching types, the French Railways have developed a design of three-axle switching unit which may be equipped with a single 380-hp engine or with two 300-hp engines. Fig. 9 is an exterior view of the unit, while Fig. 10 illustrates the equipment arrangement for the single-engine version, with space for the application of a second engine. Mechanical drive is employed. Details are given in item 6 of Table 1.

Another Australian builder has produced a road-locomotive design which, in general, follows American practice. Fig. 11 shows a 1600-hp 63-in-gage locomotive built in the South Australian Railway shops with engine and electrical equipment imported from England. Particulars on this design are given in item 7 of Table 1.

A 1400-hp standard-gage unit built by General Electric for export to Uruguay is shown in Fig. 12, and described under item 8 of Table 1.

Considerable activity is apparent among domestic and European builders in supplying narrow-gage (meter and 42-in.) diesels with relatively large engines for road service. Typical of such designs are the locomotives shown in Figs. 13 and 14. The 1000-hp unit built by Davenport (U.S.A.) for service on the Rhodesian (Africa) Railway carries two 1200-rpm Caterpillar engines, each rated at 500 hp. Limiting axle-loading and traction-motor geometry require the use of three-axle trucks with all axles motored. (Item 9 of Table 1.)

The 1100-hp 42-in-gage locomotive for Queensland (Australia) Fig. 14, has been built with greater than usual over-all length to bring the design within bridge-loading restrictions encountered on the Queensland lines. This unit is described in item 10 of Table 1.

STEAM LOCOMOTIVES

Submerged by the tide of dieselization, steam-locomotive building throughout the World has been at a low ebb during the past year. Other than orders for a small number of switchers and road freight units placed by the Norfolk & Western Railway in its own Roanoke Shops, no new steam-locomotive activity has been apparent in the United States during this period.

However, English and other European builders continue to build steam locomotives principally for export, and a notable example is to be found in the Garratt-type, fifty of which have been built by Beyer, Peacock & Company, of England for serv-

ice in New South Wales. Salient features of this design are the inclusion of one-piece cast-steel engine beds, made in the United States, and the low axle loading for the included overall power and weight. The design is conspicuous because it is the most powerful steam locomotive yet built in Europe. Roller bearings are used on all axles, and are provided for the large end of the connecting rods and for the crankpin bearings of the coupling rods. Dimensional data and other pertinent characteristics are shown under item 1 of Table 2, and the locomotive is illustrated in Fig. 15.

FIG. 5 1000-HP DIESEL LOCOMOTIVE WITH MEKYDRO DRIVE

The German Federal Railways have rebuilt (April, 1951) two steam locomotives to employ the Franco-Crosti system of boiler-water preheating. Best-point thermal efficiencies approaching 10 per cent are reported for these locomotives. Fig. 16 illustrates the locomotive, while item 2 of Table 2 lists the salient characteristic data applying.

German-built locomotives for foreign service are again appearing in world markets, and the 2-10-0 units built by Henschel & Son of Germany for service in Uruguay are illustrative of a design in which low axle loading is combined with relatively high horsepower. Fig. 17 and item 3 in Table 2 illustrate and describe these locomotives.

Another oil-burning design with light axle loading is exemplified in the British-built 4-8-2's for service on the 42-in-gage New Zealand lines. Details are given under item 4 of Table 2 and the locomotive is shown in Fig. 18.

The French National Railways have placed in passenger

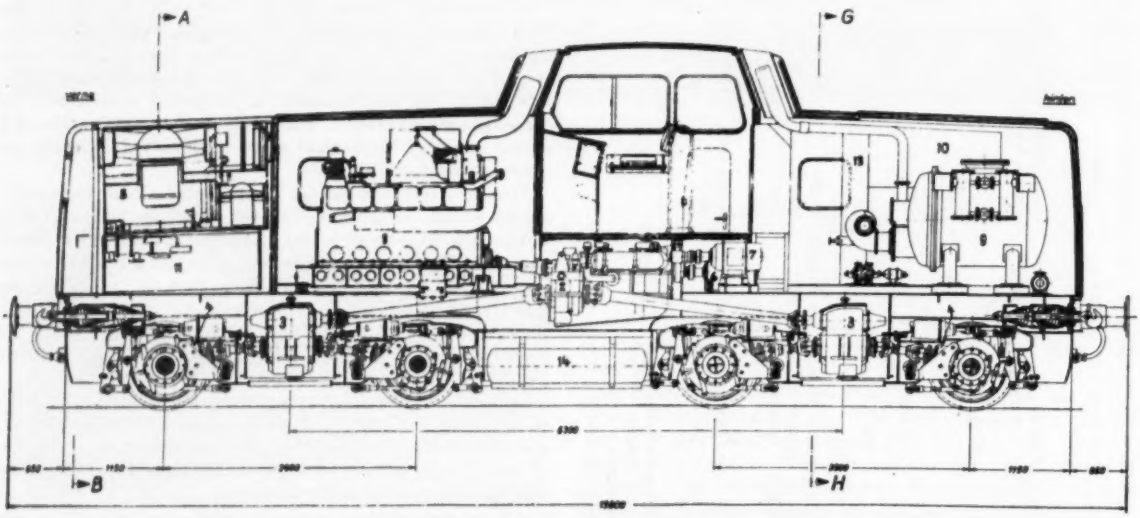


FIG. 6 SECTIONAL ELEVATION OF 1000-HP LOCOMOTIVE SHOWN IN FIG. 5

FIG. 7 TRUCK OF 1000-HP GERMAN-BUILT LOCOMOTIVE SHOWING LINKAGE USED IN LIEU OF FIXED CENTER PLATE

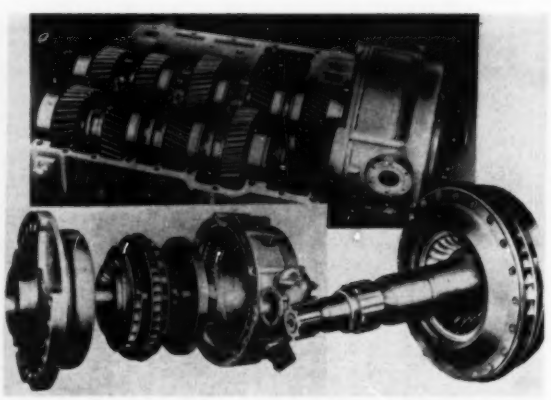


FIG. 8 MEKYDRO TRANSMISSION USED IN LOCOMOTIVE SHOWN IN FIG. 5

TABLE 2 STEAM LOCOMOTIVES

	Item 1	Item 2	Item 3	Item 4	Item 5
Builder	British[b]	German Rwys	Henschel & Son	No. British Loco.	French[d]
Owner	New So. Wales Rwys	German Rwys	Cen. Uruguay Rwy	New Zealand Rwys	FrenchRwys
Wheel arrangement	4-8-4-4-8-4	2-10-0	2-10-0	4-8-2	4-6-4
Service[a]	F	F	F	P, F	P
Cylinder dimensions (bore × stroke), in.	19 1/4 × 26	23.6 × 26.0	20.8 × 26	18 × 26	—[e]
Boiler working pressure, psi	200	227.6	227	200	285
Driving-wheel diameter, in.	55	55	60	54	78 3/4
Weight on drivers, lb	185500	184000	152500	120800	152000
Total loco weight—running order, lb	570500	209000	175000	249200	292600
Heating surfaces, sq ft	3789	1988	2189	1752	3032
Grate area, sq ft	63.4	42	42	39	55.7
Track gage, in.	56 1/2	56 1/2	56 1/2	42	56 1/2
Horsepower	—	—	1400	—	4000
Maximum permissible speed, mph	—	50	56	—	80
Tender:					
Fuel capacity, tons	16 tons	11 tons	1880 gal	1400 gal	11 tons
Water capacity, gal	9200	7950	4760	4000	7700
Weight, lb	—[c]	100200	74000	94100	179500

[a] P = passenger; F = freight.
[b] Beyer, Peacock & Co., Ltd.
[c] Tender is integral part of locomotive.
[d] Corpet Louvet et Cie, La Corneuve.
[e] 4 cylinders; two high-pressure cylinders, 17 9/16 in. × 27 9/16 in.; two low-pressure cylinders (outside frame), 26 3/4 in. × 27 9/16 in.

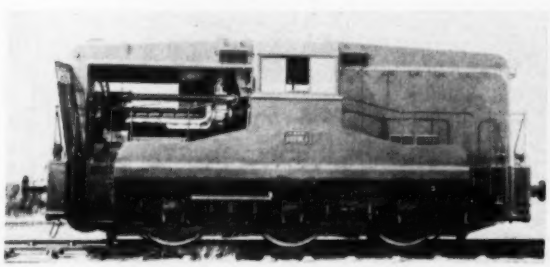


FIG. 9 FRENCH RAILWAYS SWITCHER WITH MECHANICAL DRIVE

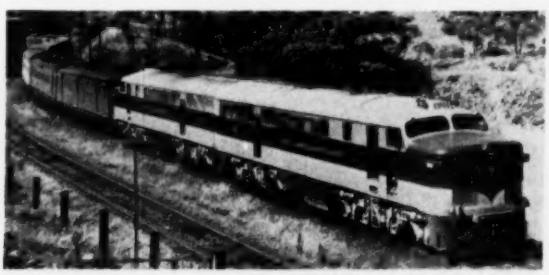


FIG. 11 1600-HP DIESEL-ELECTRIC BUILT IN NEW SOUTH WALES

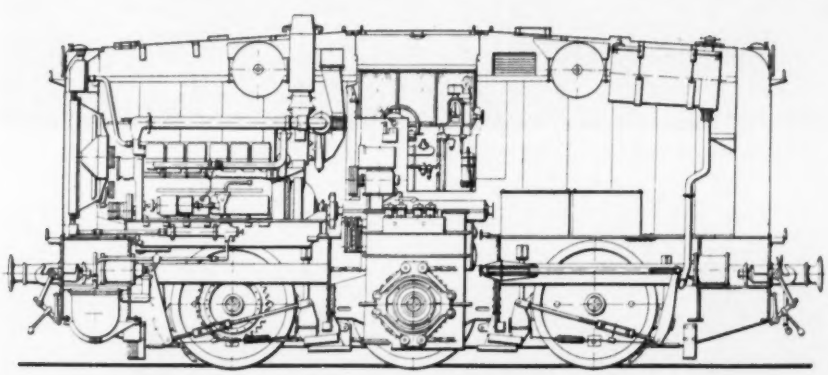


FIG. 10 EQUIPMENT ARRANGEMENT OF LOCOMOTIVE SHOWN IN FIG. 9

service a new design of a 4-6-4 engine, incorporating four cylinders and compound working. A novel feature of this design is the employment of but two sets of valve gearing for actuation of the four piston valves. The high-pressure and low-pressure valves on each side of the center line are worked by a single Walschaert link. A maximum of 4000 drawbar hp has been produced in actual running. A cross-sectional view of construction showing the inside high-pressure engines with a common steam chest is shown in Fig. 20, and an external view is given in Fig. 19. Item 5 of Table 2 gives applicable dimensional details.

ELECTRIFICATION AND ELECTRIC LOCOMOTIVES

Commercial-frequency electrification and motive power to

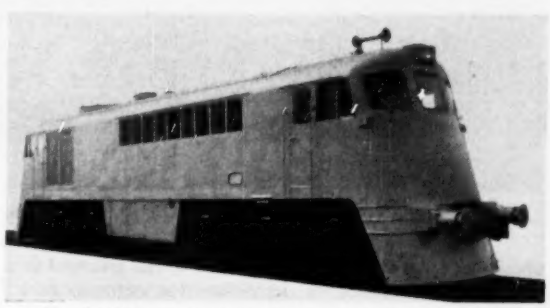


FIG. 12 1400-HP LOCOMOTIVE FOR THE URUGUAYAN RAILWAYS

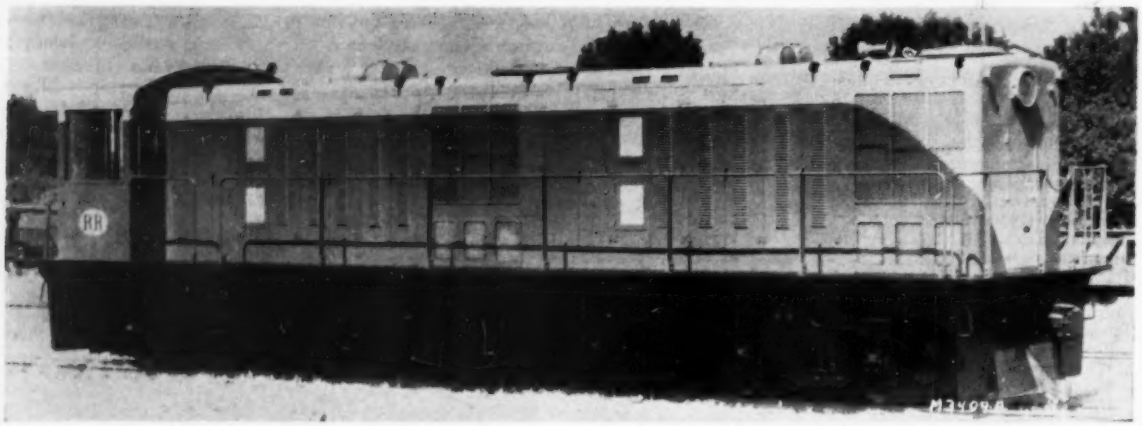


FIG. 13 DAVENPORT 42-IN-GAGE LOCOMOTIVE FOR RHODESIA

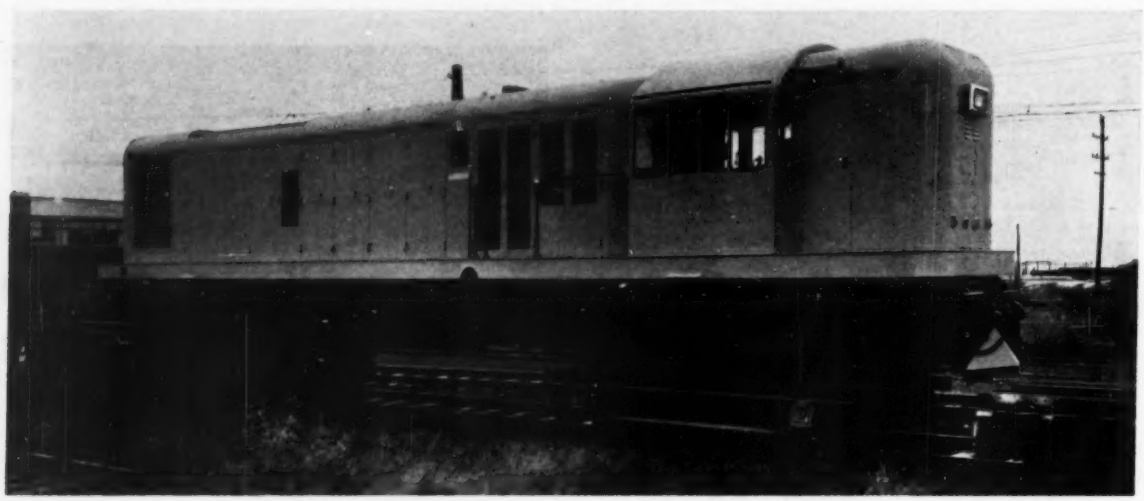


FIG. 14 1100-HP GENERAL ELECTRIC 42-IN-GAGE LOCOMOTIVE FOR QUEENSLAND

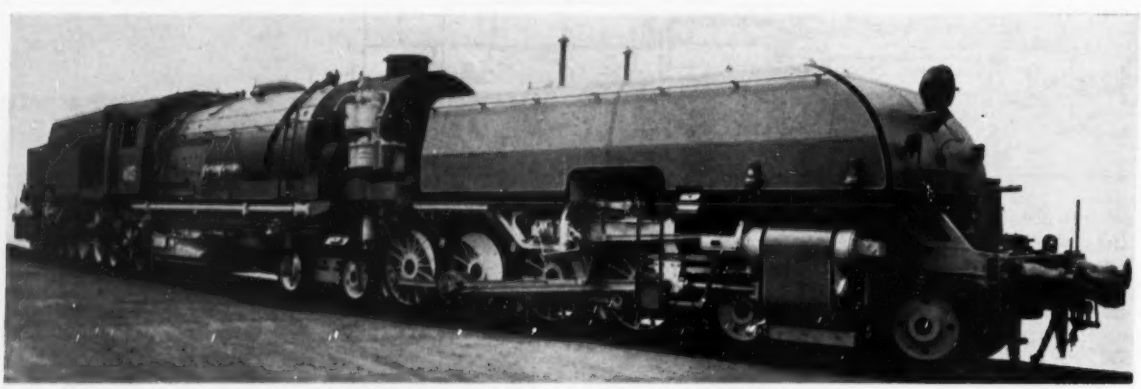


FIG. 15 GARRATT-ARTICULATED FOR NEW SOUTH WALES

operate under such a system appear to be the principal topics engaging the attention of electric-traction engineers both at home and abroad.

Encouraged by the results of the experimental 50-cycle installation on a secondary line in the South of France, the French National Railways have commenced electrification of a

FIG. 16 REBUILT LOCOMOTIVE WITH FRANCO-CROSTI WATER-PREHEATING SYSTEM

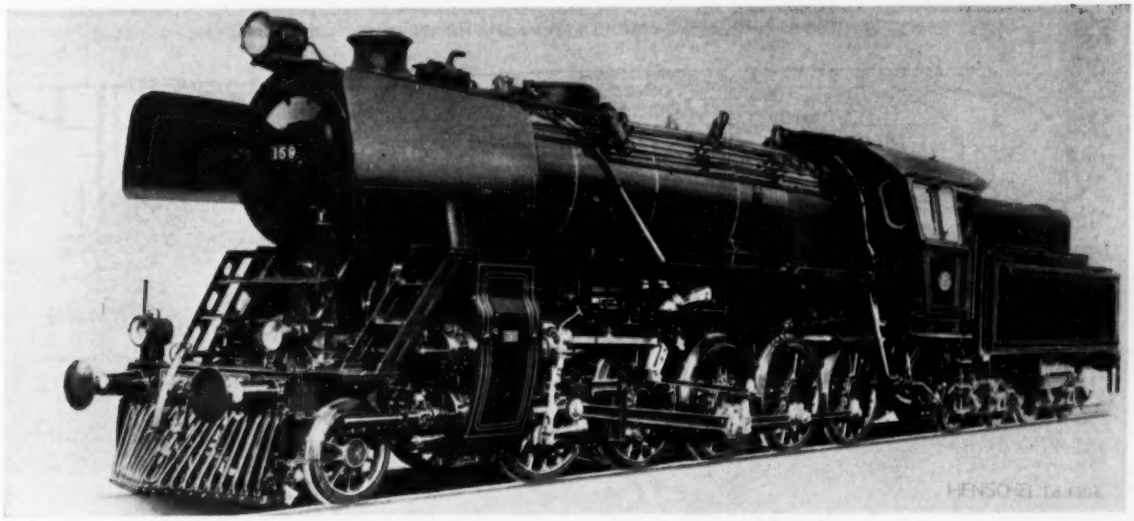


FIG. 17 GERMAN-BUILT STANDARD-GAGE 2-10-0 FOR URUGUAY

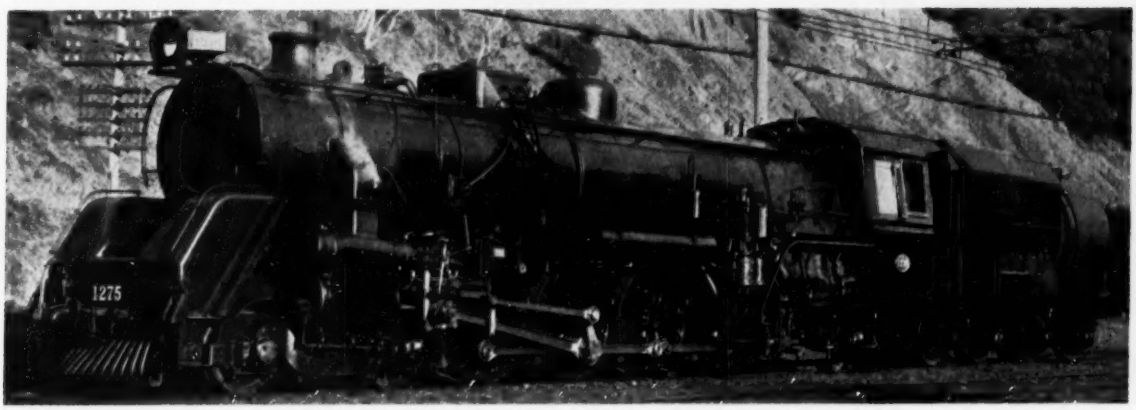


FIG. 18 42-IN-GAGE OIL-BURNING STEAM LOCOMOTIVE FOR NEW ZEALAND

heavy-freight-hauling line in the north of France. The line extends over a route distance of some 220 miles and serves the heavily industrialized area between Valenciennes and Thionville in northeastern France. A mixture of mercury-arc-rectifier motive power and motor-generator locomotives—the latter are intended for line power-factor and voltage improvements—are contemplated.

The British Railways are undertaking to equip a section of their lines with a commercial-frequency (50 cycles) electrification for experimental purposes.

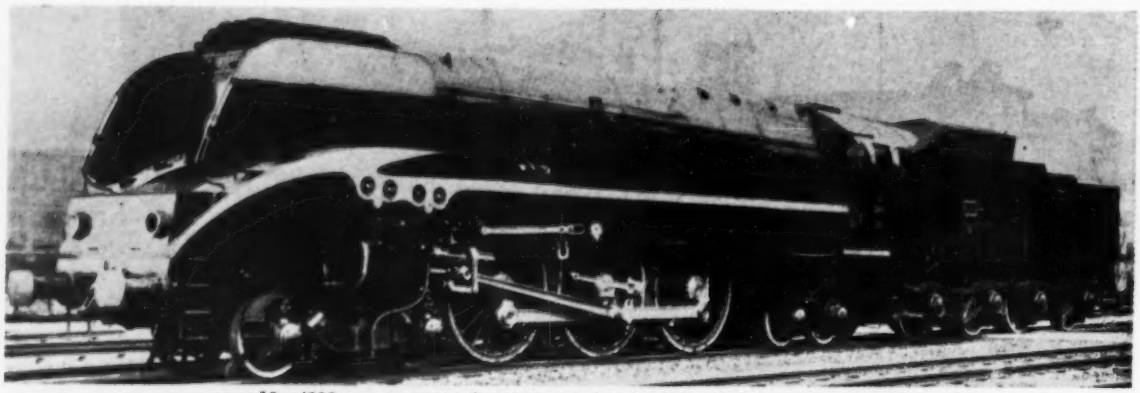


FIG. 19 4000-HP COMPOUND 4-CYLINDER STEAM LOCOMOTIVE ON FRENCH RAILWAY

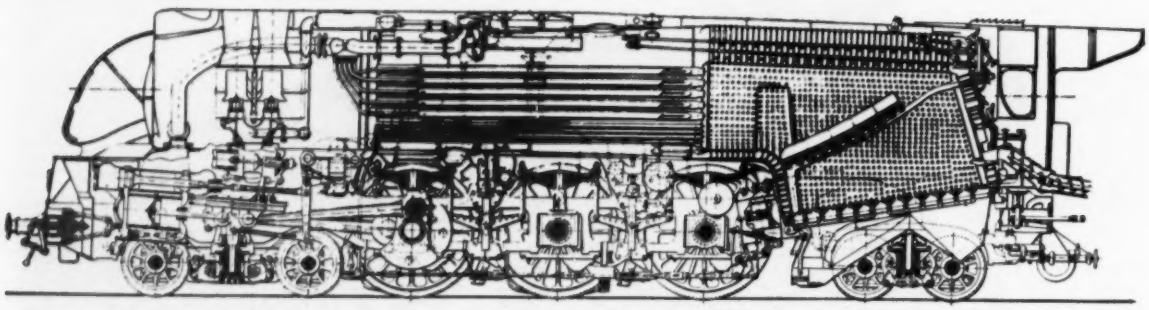


FIG. 20 SECTIONAL ELEVATION OF 4-CYLINDER STEAM LOCOMOTIVE

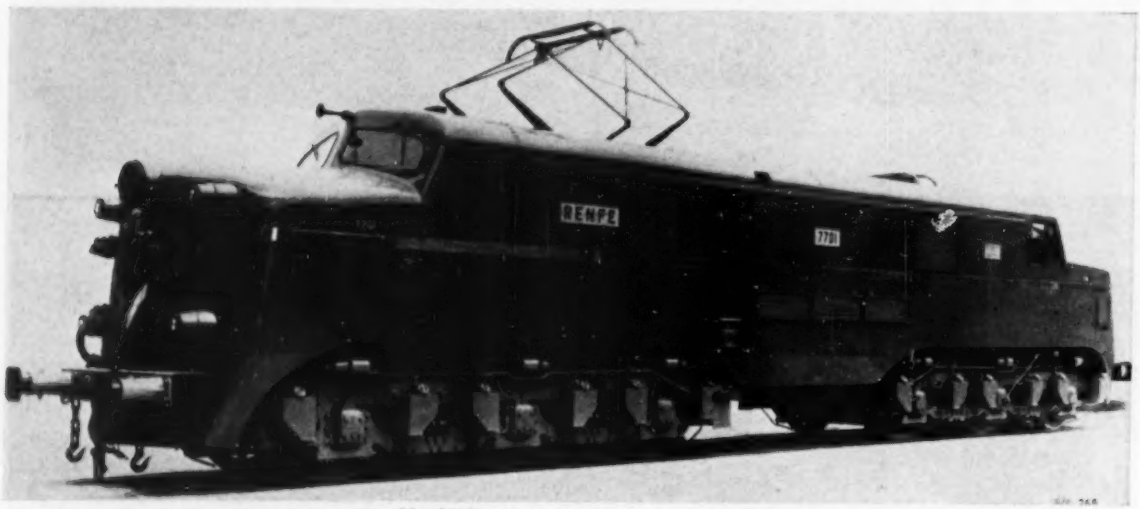


FIG. 21 3000-V ELECTRIC LOCOMOTIVE FOR SPAIN

A 50-cycle electrification is in process of installation on a narrow-gage light-traffic line in the Belgian Congo.

While railroad electrification in the United States is currently characterized by abandonments rather than extensions, the Joint Committee on Railroad Electrification (an industry co-operative research activity sponsored by Edison Electric Institute in conjunction with some Eastern railroads, coal companies, and equipment manufacturers) has recommended further study of commercial-frequency electrification for domestic railroads (2).

Despite the current interest in commercial-frequency electrification some countries continue to expand established systems and to acquire new motive-power designs.

The Spanish National Railways (RENFE) have taken initial delivery on a lot of 60 C-C 3000-v 3600-hp locomotives built in England and engineered by the English Electric Company, Limited. These are claimed to be the most powerful electrics yet built in England. Fig. 21 illustrates and item 1 of Table 3 gives salient data applying to these machines.

Fig. 22 and item 2 of Table 3 describe a 1500-v d-c design

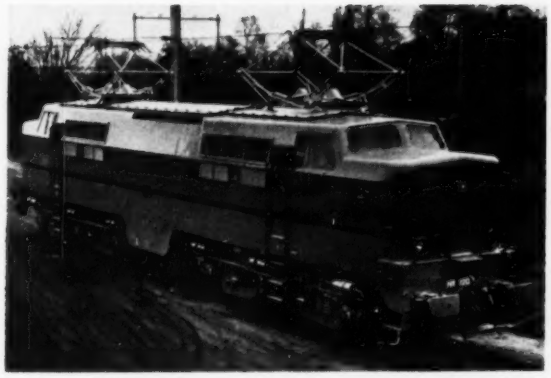


FIG. 22 1500-V LOCOMOTIVE BUILT IN HOLLAND TO AMERICAN DESIGNS

FIG. 25 2-D-2 1500-V LOCOMOTIVE WITH FLEXIBLE DRIVE

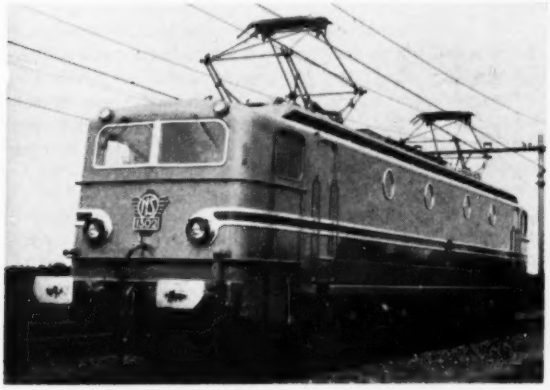


FIG. 23 FRENCH-BUILT 1500-V ELECTRIC FOR NETHERLANDS

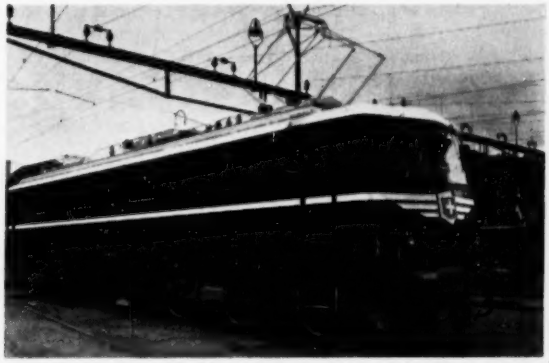


FIG. 26 A-C ELECTRIC FOR OPERATION ON SWISS FEDERAL RAILWAYS

FIG. 24 FRENCH RAILWAYS 1500-V LOCOMOTIVE RATING 4270 HP

FIG. 27 3000-V METER-GAGE ELECTRIC FOR BRAZIL

engineered in the United States (by Baldwin-Westinghouse) and built in Holland by Heemaf for the rehabilitated Netherlands Railways. Both the Spanish and Dutch locomotives employ the extended-nose cab construction first introduced on domestic locomotives built in 1936 for the New Haven and subsequently extensively popularized in practically all road diesel-electric locomotives in the United States.

A C-C 1500-v design rating 3800 hp on a continuous basis is shown in Fig. 23, and described under item 3 of Table 3.

New designs for the French National 1500-v d-c lines are shown in Figs. 24 and 25. Fig. 24 illustrates a high-powered machine (4270 hp continuous) on a C-C running gear with conventional individual motored-axle drive, while Fig. 25 shows a 2-D-2 wheel arrangement with frame-mounted motors and individual-axle flexible drives mounted outside the locomotive framework. (Items 4 and 5 of Table 3.)

Another example of a high-powered electric locomotive mounted on a C-C running gear is shown in Fig. 26. This was built for operation on the a-c lines of the Swiss Federal Railways and is characterized by a rating of 5190 hp on a continuous basis. Details are shown in item 6 of Table 3.

Fig. 27 depicts a meter-gage design developed by Metropolitan-Vickers of England as a "standard" for narrow-gage 3000-v lines in Brazil. Outside-hung swing links with rubber

TABLE 3 ELECTRIC LOCOMOTIVES

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7
Railroad	Spanish Rwys	Netherlands Rwys	Netherlands Rwys	French Rwys	French Rwys	Swiss Rwys	Brazil[e]
Builder, mechanical	Vulcan Foundry	Werkspoor	Alsthom	Alsthom	Ste Fives-Lille	Swiss[d]	British[f]
Builder, electrical	English Elec	Heemaf	Alsthom	Alsthom	French[c]	Brown Boveri	Metro.-Vic.
Wheel arrangement	C-C	C-C	C-C	C-C	2-D-2	C-C	B-B
Service[a]	P, F	P, F	P, F	P	P	P, F	P, F
Power supply	3000 v, d-c	1500 v, d-c	1500 v, d-c	1500 v, d-c	1500 v, d-c	15,000 v, a-c	3000 v, d-c
Current collector	Pantograph	Pantograph	Pantograph	Pantograph	Pantograph	Pantograph	Pantograph
Driving wheels:							
Number	12	12	12	12	8	12	8
Diameter, in.	48	43	49 1/4	49 1/4	69	49 5/8	43
Weight, lb:							
Total	264000	240360	244700	224600	331000	265000	110200
On drivers	264000	240360	244700	224600	202800	265000	110200
Per driving axle	46000	40060	40780	37430	50700	44200	27550
Dimensions, ft-in.:							
Length over-all	67-9	59-4	62-2 1/8	62-0	71-3	60-5	39-6
Width over-all	10-1	10-1	10-1	9-9	11-8 9/10	9-8 1/4	8-6
Height, pantograph down	14-0	14-9 1/2	14-5 7/8	13-10	16-7 3/10	14-9	13-1
Rigid wheel base	15-9	15-6	15-10	15-10	24-2 1/4	14-1 1/2	8-6
Total wheel base	50-7	45-6	46-4 3/4	46-4 3/4	57-10 13/16	42-8	27-0
Traction motors:							
Number	6	6	6	6	4	6	4
Method of mounting	Axle-hung	Axle-hung	Spring	Axle-hung	Quill	Axle-hung	Axle-hung
Method of drive	Spur gears	Gear and pinion	—[b]	Gear and pinion	Flexible drive	Spring	—[g]
Gear ratio	63/16	71/20	1/3.7	2.606	—	1/2.22	17/74
Tractive forces:							
One-hour rating, lb	38300	—	34000	36400	46600	46800	15300
Per cent adhesion	14.5	—	13.9	16.2	22.9	17.7	13.9
Continuous rating, lb	30400	23600	31400	30800	40250	39800	11900
Per cent adhesion	11.5	9.9	12.8	13.7	19.8	15.0	10.8
Horsepower:							
One-hour rating	3480	—	—	4760	5380	5730	1060
Continuous rating	2920	3270	—	4270	4870	5190	870
Speed, mph:							
One-hour rating	34	—	—	49	43.2	46	25.9
Continuous rating	36	51.8	—	52	45.3	48.8	27.3
Maximum speed, mph	68	93.8	84.5	100	93.4	77.7	50
Regeneration	Yes	No	No	—	—	Yes	No
Multiple-unit operation	Yes	No	No	—	—	No	No
Track gage, in.	66	56 1/2	56 1/2	56 1/2	56 1/2	56 1/2	39 3/8

[a] P = passenger, F = freight.
[b] Completely sprung hollow axle.
[c] Cie Electro-Mechanique.
[d] Swiss Locomotive and Machine Works.
[e] Rede Mineira de Viacao.
[f] Metropolitan-Vickers Electrical Co., Ltd., and Beyer, Peacock & Co., Ltd.
[g] Single-reduction, straight spur resilient gear wheel, solid pinion.

universal joints substitute for the conventional fixed-center-plate and floating-bolster construction which is customarily found in locomotives of this weight class. (Item 7 of Table 3 on page 300.)

GAS-TURBINE LOCOMOTIVES

Experimental operation of a number of gas-turbine locomotives continues in the United States, England, and France, and unconfirmed rumor has it that an experimental unit has been built in Eastern Germany under Russian auspices.

While six 4500-hp units have been delivered during the past year by General Electric for service on the Union Pacific on a commercial order, these must still be considered as experimental units. Basically the "commercial" units are similar to the pilot model built by General Electric (3), and differ primarily in that the later units are built to operate single-ended, have greater fuel capacity and increased axle loading. Dimensional data are given in item 1 of Table 4 and one of the new units is shown in Fig. 28. An ASME paper (4) delivered before the Society at its Annual Meeting 1952 describes the experience secured with the new units up to mid-summer of 1952.

At the completion of the modifications on the fuel and control systems which were reported last year, the Westinghouse-Baldwin gas-turbine-electric locomotive (6) was returned to service for further operating experience. The locomotive was placed in service on the Pennsylvania Railroad for 6 weeks making daily round trips between Harrisburg, Pa., and Altoona, Pa., with nonstop mail and express trains. During this period the locomotive accumulated 7100 miles and demonstrated that greatly increased reliability had been attained as a result of the modifications. Most of the Pennsylvania Railroad operation was with residual fuel.

Following this operation the locomotive was moved to the Midwest to take full advantage of the low cost of residual fuels when purchased and utilized close to their source. The Missouri-Kansas-Texas Lines operated the locomotive in passenger service between Parsons, Kan., and Denison, Tex., for 90 days. Of the 27,775 miles of revenue service logged, all but the first several days' operation was on residual fuel. In this heavy-fuel service the fuel and lubricating oil cost was the same as that for diesel-electric locomotives in the same service.

Reliability of the locomotive in service on the Missouri-Kansas-Texas Lines continued good for an experimental unit. Two assigned trips were missed and one delay occurred en route. Respectively, these were caused by a broken fuel-pump coupling and two air-pipe breaks. Continual improvement in combustor and nozzle designs has resulted in improved performance and reduced maintenance for these items.

Following the 90-day operation on the Missouri-Kansas-Texas, the turbines were disassembled to inspect the inner parts for signs of distress. In spite of the extended burning of residual fuels which had not received special treatment, no indications of appreciable erosion or corrosion were found on the rotor blading. Incipient thermal cracks were found on the first disks of the rotor and a design modification was made to alleviate this condition. Some of the first-row stationary blading contained nicks and cracks. The absence of serious difficulties indicated that the problems associated with the burning of residual fuels in gas turbines are being solved.

Extensive testing (5) and service running have been experienced with the 2500-hp Brown Boveri gas-turbine-electric (6) built for the British Railways.

A significant fact confirmed by these tests is that the gas-turbine locomotive in its currently conceived form is basically a "high-load-factor" form of motive power, and unless it is used in services where power-plant load factor is relatively high, disappointingly low thermal efficiency and high fuel consumption are experienced.

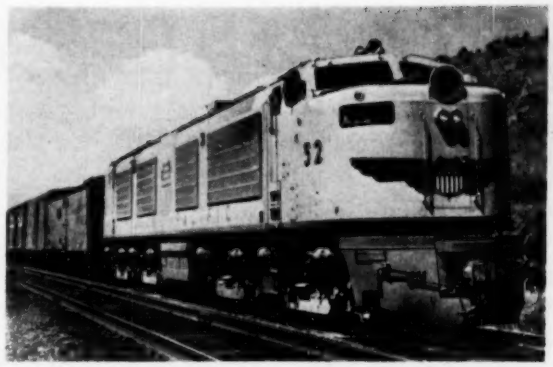


FIG. 28 GENERAL ELECTRIC GAS-TURBINE-ELECTRIC BUILT FOR UNION PACIFIC

The British Railways inaugurated operation of the first British-built gas turbine-electric locomotive, designed and constructed by Metropolitan-Vickers. The unit, described under item 2 of Table 4 and illustrated in Fig. 29, is a 3000-hp

TABLE 4 GAS-TURBINE LOCOMOTIVES

	Item 1	Item 2
Owner	UP	British Rwys
Builder	Gen. Electric	Metro.-Vickers
Wheel arrangement	B-B-B-B	C-C
Service	Freight	Passenger
Weight on drivers, lb	520000	292000
Total weight, lb	520000	292000
Length over-all, ft-in	83-6 1/2	66-9 1/4
Fuel	Oil	Oil
Fuel capacity, gal	7200	995
Driving-wheel diam, in	40	44
Type of drive	Electrical	Electrical
Gage, in	56 1/2	56 1/2
Maximum speed, mph	69.3	90.0
Turbine data:		
Number	1	1
Horsepower	4500	3000
Speed, rpm	6900	7000
Manufacturer	Gen. Electric	Metro.-Vickers

machine employing a simple open-cycle, nonregenerative turbine-compressor unit burning heavy oil. Novel in the locomotive mechanical structure is the method employed for carrying the cab structure on the C-C running gear. Outside-hung swing links with resilient-rubber universal joints permit a controlled swing-bolster action and truck pivoting, without the actual use of bolsters of the conventional inside-mounted floating type.

The North British Locomotive Company has under construction a 1600-hp coal-burning gas-turbine locomotive with mechanical drive. Two turbines will be used. The air compressor will be driven by a high-pressure turbine and traction power will be furnished by a low-pressure turbine driving into a two-stage gearbox. Exhaust air from the traction turbine will be used for combustion purposes and for tempering the products of combustion before they enter the heat exchanger. Air from the compressor is to be led through the heat exchanger, thence to the compressor-turbine and from this to the traction turbine. The products of coal combustion thus will not pass through either turbine.

The locomotive running gear will consist of two three-axle trucks, with wheels in each truck side-rod coupled. The locomotive is being designed to weigh approximately 132 tons.

A free-piston gas generator turbine locomotive with mechani-

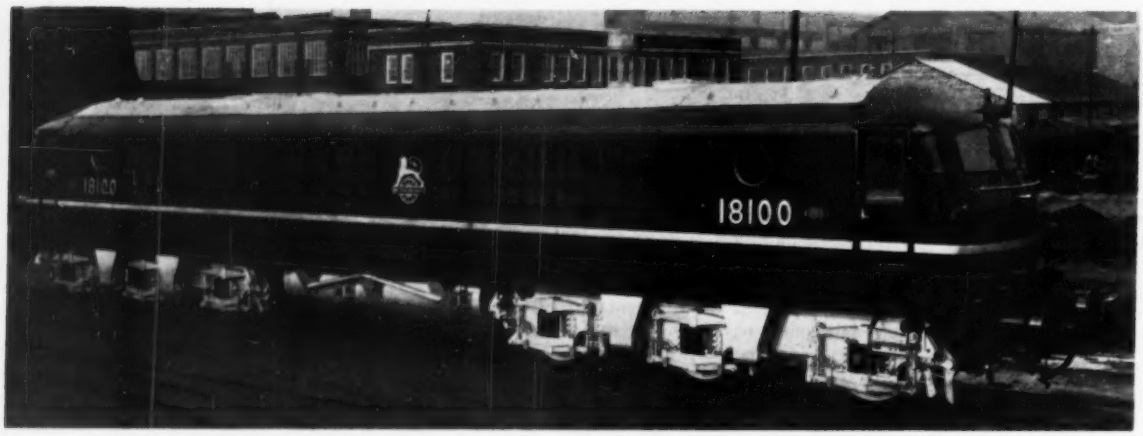


FIG. 29 3000-HP METROPOLITAN-VICKERS GAS-TURBINE-ELECTRIC FOR BRITISH RAILWAYS

cal drive is being operated in experimental service on the French National Railways. This unit is built on a B-B running gear with drive from a centrally located gearbox in the cab structure through universally jointed shafts to each of the two trucks. The unit is nominally rated at 1000 hp, weighs approximately 60 tons in a length of 49 ft 3 in. A small diesel engine provides power for the operation of auxiliary equipment. The main gas generator is a single-cylinder, opposed-piston Pescara diesel of the free-piston type.

The Swedish firm of Motola Verkstad has under construction a 1000-hp power-gas locomotive, in which the gas producer is to be a five-cylinder two-cycle diesel with scavenging compressor. Gas will be generated at approximately 60 psi and will be fed to the turbine, which is coupled to the driving wheels through reduction gears, jackshaft, and side rods. The locomotive will weigh approximately 78 tons and is expected to develop a starting tractive effort of 27,000 lb.

DIESEL RAIL CARS, TRAINS, AND BUSES

In the post World War II years, and particularly during the past year, there has been a resurgence of diesel rail-car and train construction in European countries, and the past year has witnessed the introduction of a number of notable designs. The trend in transmissions appears to be away from electric drive to mechanical drive employing hydraulic couplings with gear-change sets, or hydraulic torque converters with one or two gear ratios to extend the speed-operating ranges.

While emphasis has been predominantly, in the United States, on diesel locomotives, the rail-car nevertheless has taken on a new lease of life, particularly in the expanding use of the Budd-built diesel cars with torque-converter transmission.

The rail bus, which has enjoyed a limited use in some foreign countries, has reappeared on the American scene in the form of a 50-passenger Mack-built diesel-electric vehicle, operating on the New Haven Railroad. This car, or rail bus, is essentially a bus body mounted on PCC (Presidents' Conference Car) streetcar trucks. The bus is shown in Fig. 30. A 220-hp Mack diesel engine with General Electric equipment, consisting of a single generator and four urban-traction motors, comprises the power train for the vehicle. Oddly enough, one of the most serious operating problems encountered with the use of this relatively lightweight car, which does not utilize brake shoes working on the wheel treads, is the reluctance of the vehicle to operate the conventional low-voltage track-signal equipment.

An interesting and unusual design of rail-car train built in Denmark is the 1000-hp combination, wherein two 500-hp engine-generator sets are mounted side by side on a three-axle nonmotored truck, Fig. 31. This truck is the leading truck of the leading car of the rail train. The trailing truck of this car carries two traction motors, and a nonengined four-motored trailer taking power from the engined car, is always run in combination with the lead car. Speeds up to 75 mph are negotiated successfully with this combination.

A luxury rail car, Fig. 32, built in Italy, incorporates an observation dome similar to the domestic "Vistadome" or "Astradome" designs employed in the United States. Motive power is provided by two 150-hp 1500-rpm engines, one engine being mounted in each of the two trucks and driving a single axle through a Lysholm-Smith hydraulic torque converter.

FIG. 30 MACK-BUILT DIESEL-ELECTRIC RAIL BUS FOR NY NH & H RR

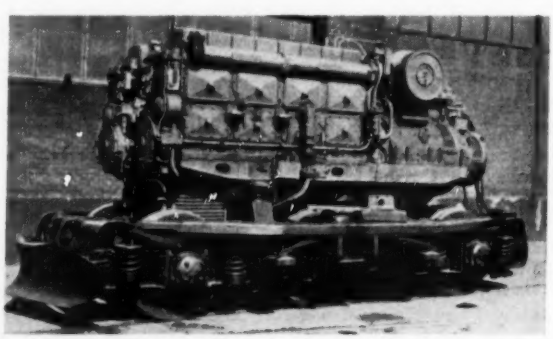
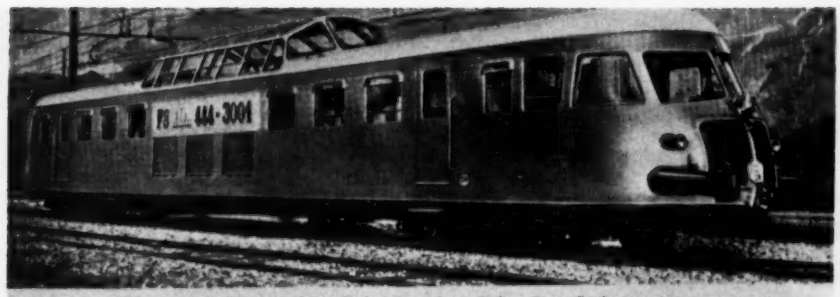


FIG. 31 1000-HP POWER TRUCK FOR DANISH RAIL TRAIN



Twin-engine diesel hydraulic railcar, Italian State Railways

Floor plan of observation railcar

FIG. 32 ITALIAN HYDRAULIC-DRIVE RAIL CAR WITH OBSERVATION DOME

The car, providing seats for 44 passengers, weighs 45 tons with passenger load and fuel supply for a run of 560 miles.

PASSENGER-TRAIN CARS

Early this year the Pennslyvania received 64 new stainless-steel passenger cars from the Budd Company to make up two new 18-car "Congressional" trains for morning and afternoon schedules between Washington and New York, and two 14-car "Senator" trains for daily Washington-Boston runs. Nine different plans or types of cars make up the two consists. Special features of these new trains include a radio telephone service, electric kitchens in the diners, and a "radar" range in the coffee shop. One novel type of car is used on the Congressional—a seven all-drawing-room car designed for day occupancy. Six of these rooms are arranged so that they may be opened in pairs, giving large rooms for meetings or conferences. New heating systems using circulating hot water as a secondary heating medium are used on certain cars, and a new system developed by Budd is used on the drawing-room car. Car weights range from 123,040 lb for the parlor car to 154,340 lb for the kitchen-bar-lounge. Fig. 33 shows the interior of a parlor car.

Indicative of the popularity of the dome car, Pullman-Standard Car Manufacturing Company delivered to the Missouri Pacific and Texas & Pacific five dome-type coaches. The domes seat 24 passengers in coach-type seats and the main or normal level has a total of 42 coach seats at the two ends. There are two lounges seating 15 people in the depressed center section under the dome. Washrooms adjoin these lounge sections. The cars have plain painted sides and are built of high-strength steel throughout. Because of the large glass area in the dome a 10-ton air-conditioning system is used.

Late in 1951, and early 1952, the Paulista Railroad of Brazil received from Pullman-Standard Car Manufacturing Company 48 new passenger-train cars comprising 6 baggage and mail cars, 15 first-class coaches, 15 second-class coaches, 6 diners, and 6 parlor cars. These cars have wide-gage 63-in. trucks. The general body dimensions conform to the standard American 85-ft lightweight passenger car. The cars were built to American strength standards of high-tensile steel, have tight-lock couplers, UC type air brakes, and trucks similar to those used in modern high-speed United States trains. The cars were

FIG. 33 INTERIOR OF "CONGRESSIONAL" PARLOR CAR

specially designed in conjunction with the Paulista Railroad officials to give modern cars according to American practices and especially suited for the climate, operating conditions, and traffic of the Paulista Railroad. No heating is used on any cars. Air conditioning is used on the diners and parlor cars. A forced-draft ventilating system was designed especially for the first and second-class coaches. Fig. 34 shows the body of the dining car.

The C&O Railway, in conjunction with the Pullman-Standard Car Manufacturing Company, conducted tests on a "Train X" passenger car, with a group of interested railroad officials aboard. The cars of Train X (7) are constructed as single-axle lightweight vehicles designed to run in a fixed train consist similar in conception to the arrangement utilized by the American Car & Foundry Company "Talgo" train (8).

FREIGHT-TRAIN CARS

During the past year domestic freight-car production continued at a high rate and was limited largely by availability of steel. While the majority of production was of standard types of cars, a number of special and new designs also were introduced.

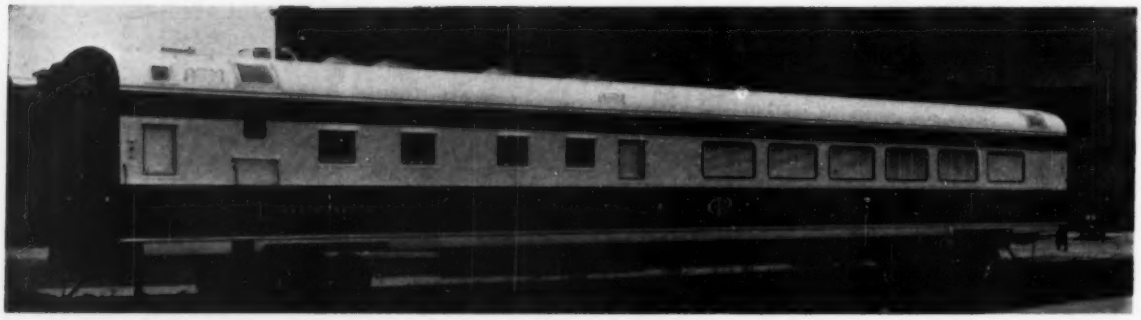


FIG. 34 DINING CAR FOR SERVICE IN BRAZIL

FIG. 35 100-TON ALL-WELDED FLAT CAR FOR U.S. ARMY

Studies and development work are under way by a number of railroads and manufacturers, and great efforts are directed in two paths:

1 Development of special cars for specific loading.

2 Studies of cushioning devices and loading retaining devices, all with the goal of minimizing lading damage in transit.

The Union Pacific built a special boxcar with a clear plastic side to demonstrate loading techniques. Similar types of cars for testing and educational use are on the drawing board.

New types of lading anchors are being used in boxcars to aid in holding the load in position.

Pullman-Standard completed 25 boxcars with their compartmentizers. This is a movable crosswise gate which can be locked in position at longitudinal location in the car and holds the lading in position, minimizing shifting and resultant damage.

During the past year a number of special flatcars were built. Most of them had depressed centers, ranged in capacity from 95 tons to 250 tons, and were designed largely for hauling heavy machinery and electrical equipment. Some of these are described later, but similar-type cars were built by Great Northern, Erie, Wabash, Delaware & Hudson, and New York Central in their own shops.

Pullman-Standard Car Manufacturing Company built for the Army Transportation Corps 105—100-ton all-welded flatcars, designed for operation in passenger cars at passenger-train speeds. The cars are 50 ft long and weigh 110,000 lb light. The General Steel Castings Company's 6-wheel passenger-car-type trucks have $6^1/_2$-in. × 12-in. axles, truck-mounted cylinders and clasp brakes designed for 250 per cent emergency braking. Air brakes are passenger-type HSC with D-22-AR control valves. Insulated steam train lines are used to permit passenger-train operation. Fig. 35 illustrates these cars.

The Pennsylvania Railroad built in its own shops one 250-ton-capacity depressed-center flatcar. The car—or more aptly—the unit is 124 ft 3 in. long over pulling faces of the couplers and weighs 500,400 lb light. At each end of the car is a pair of 8-wheel trucks. The two pairs of trucks support a platform which includes the draft rigging, hand brake, safety appliances, and so on. The body of the car spans these two platforms and is supported on center plates on 73-ft 6-in. centers. Essentially, this makes an articulated unit. The well or depressed center of the body is 27 ft long at a height of $39^7/_8$ in. above the rail. The car is shown in Fig. 36.

Late in 1951 the Pennsylvania completed nine 75-ft-4-in-long flatcars with a 30-ft-long depressed loading platform 30 in. above the rails. The car, which has a load limit of 332,700 lb and a lightweight of 169,300 lb, has a cast-steel underframe and is carried at each end on two pairs of trucks using $6^1/_2$ × 12-in. journals. The car is shown in Fig. 37.

Greenville Steel Car Company built for the Westinghouse Electric Corporation two 175-ton depressed-center flatcars having a 27-ft well $29^3/_4$ in. above the rail. The built-up welded-steel underframes are supported at either end by a platform which carries the draft-gear coupler mechanism, hand brake, safety appliances, and the like, and each platform in turn rests on a pair of $6^1/_2$-in. × 12-in. freight-car trucks. This unit also is articulated in its functioning.

Greenville Steel Car Company built for the B&LE 500 steel ore cars designed for long-haul road service, which permitted increasing the length of the car 8 in. over the customary 24-ft ore car. Empty and load type brakes, using only one brake cylinder, were used.

During the past year Pullman-Standard designed and built for the Transportation Corps of the U. S. Army two pilot models each of four types of cars: (*a*) 40-ton flatcars; (*b*) 40-ton high-side gondolas; (*c*) 40-ton low-side gondolas;

FIG. 36 250-TON WELL CAR BUILT BY PENNSYLVANIA UTILIZING STEAM-LOCOMOTIVE TENDER TRUCKS

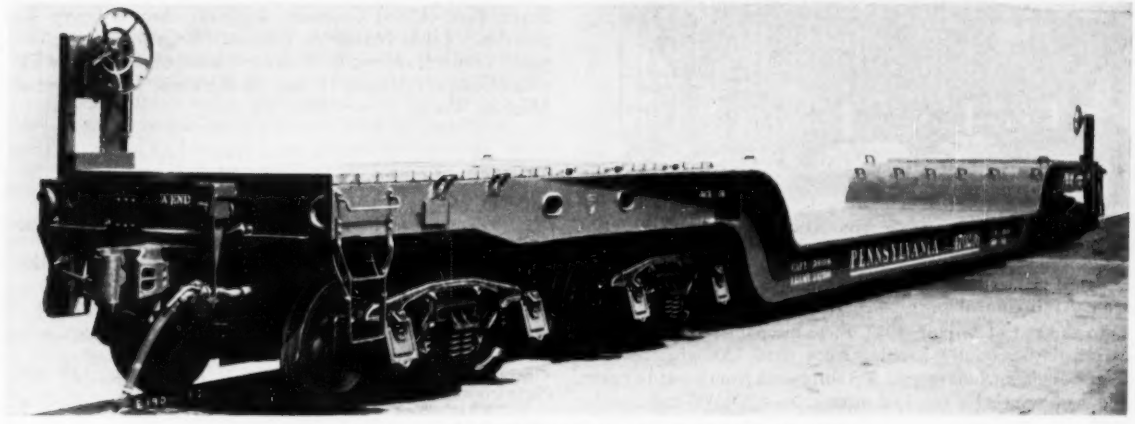


FIG. 37 DEPRESSED-CENTER CAR WITH CAST-STEEL UNDERFRAME

FIG. 38 STANDARD FLATCAR FOR ARMY TRANSPORTATION CORPS

and (*d*) 40-ton boxcars. All cars have interchangeable welded-steel underframes, running gear, brakes, and trucks. The box-car sides, ends, and roofs are of plywood, while the gondola sides and ends are of T&G lumber. The cast-steel trucks of the cars that were built are for 4-ft $8^1/_2$-in. gage but also can be used for 5-ft 0-in. gage by adjustments in the truck parts and by moving the wheels outwardly on the axle-wheel seat. By the substitution of longer axles, longer bolsters, and brake beams, 5-ft 3-in and 5-ft 6-in-gage trucks also can be assembled. The cars were built with KC-type air-brake equipment. Fig. 38 shows the flatcar.

The Bureau of Ordnance of the Department of the Navy received from Pullman-Standard 880 50-ft 6-in. boxcars especially designed for handling ammunition. Chrysler trucks of Symington-Gould manufacture and Duryea underframes using Waugh rubber draft gears are employed for cushioning the lading against impacts and normal road shocks and vibration. Special Evans loading devices developed by the Navy and Evans permit load blocking on $^1/_2$-in. increments both vertically and longitudinally of the car.

The Magor Car Corporation built for the Columbian Carbon Company a number of special hopper cars to handle bulk carbon black. These cars have special hatches in the roofs for loading and three hoppers on the underside for unloading. Fig. 39 illustrates one of these cars.

During the past year Fruit Growers Express Company has increased its fleet of mechanically refrigerated cars to a total of 165 cars, consisting of 102 70-ton-capacity 50-ft cars and 52

50-ton-capacity 40-ft cars using the Frigidaire system of mechanical refrigeration, and 11 50-ton-capacity 40-ft cars using the Thermo-King system of refrigeration. In addition, Western Fruit Express Company, associated with Fruit Growers Express Company in operating refrigerator cars, has 60 mechanically refrigerated cars on order to be equipped with the Frigidaire system. When these are completed the two companies will have a total of 225 mechanical cars in service. These cars are

FIG. 39 COVERED HOPPER FOR HANDLING CARBON BLACK

designed primarily to provide zero temperatures and improved temperature control for shipments of frozen foods.

To the end of August, 1952, these mechanically refrigerated cars had successfully handled more than 3200 shipments of frozen foods, including over 500 shipments from coast to coast, and had traveled a total of more than 4,700,000 miles under load.

The Frigidaire equipment, located in a compartment at one end of the car about the size of the ordinary ice bunker, consists of a refrigerant compressor, condenser and evaporator coil, powered by an alternating-current generator driven by a 34-hp diesel engine.

The Thermo-King system uses two gasoline-engine-driven compressor-condenser units, both located in a compartment at the end of the car. Each unit is readily removable for ease of maintenance and replacement.

The New South Wales Government Railways of Australia placed in service 260 new refrigerator cars designed after extensive studies of cars used in the United States, Canada, and England. These cars are 38 ft long, have a capacity of 32 tons, a steel frame with a flush waterproof plywood interior lining. Eight tanks located in the roof of the car carry ice rather than the conventional end bunkers. Wooden trays form a false ceiling and carry away condensation and splash to galvanized ducts placed between the inner and outer walls. These ducts also provide a path for circulation of air through the car.

The Canadian National Railway is experimenting with a new refrigerator car. This car is unlike the mechanical refrigerator cars now in operation on United States railroads, in that the refrigeration equipment is not housed in the body of the car. To preserve full cargo capacity of the car a 34-hp diesel-engine driving an electric generator is housed in one unit underneath the car. The refrigerator unit, including the motor-driven compressor, condenser, electric control panel, temperature-selector switch and thermostatic control are assembled in a second unit, also mounted underneath the car. Two evaporators, which circulate cool air throughout the car, are placed between the ceiling and the roof of the car. The evaporator-blower systems also contain electric heater elements which may add heat to the car in case the outside temperatures necessitate heating. A false ceiling is installed in the car to facilitate air circulation. The blowers, located above the ceiling, draw air from one side of the car and force it down vertical ducts at close intervals on one side of the car. This air then passes under the floor racks and up similar ducts on the opposite side of the car.

ACKNOWLEDGMENTS

The Committee gratefully acknowledges assistance in procuring data for the report given by the railway press of the United States; by the *Railway Gazette* of England; by the many domestic railways, locomotive, car, and equipment builders of the United States; by the British Railways; French National Railways; German State Railways; Netherlands Railways; New Zealand Government Railways; South Australian Railways; Beyer, Peacock and Company, Limited; Brown Boveri Corporation; Clyde Industries, Limited; English Electric Company, Limited; Henschel & Son; Metropolitan-Vickers Electrical Company, Limited; and by the Swiss Locomotive and Machine Works.

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Business Leadership in a Democracy

(*Continued from page 286*)

prospect! In this country, with its rich, natural resources and with our increasing insight into the secrets of nature, we can have our brand of civilization come to full flower in the rediscovery of the individual—each individual a member of the team; each individual unique. I am convinced that in seeking to attain such goals, business need not go soft or become inefficient. A century ago the good gray poet of democracy, Walt Whitman, went about the land expounding, in his Sears Roebuck type of poetry, the essence of democracy. He ends one of his epic poems with these lines:

It is not the earth, it is not
America who is so great,
It is I who am great or to be great,
it is You up there, or any one,
It is to walk rapidly through
civilization, governments, theories,
Through poems, pageants, shows
to form individuals.
Underneath all, individuals; I swear
nothing is good to me now that
ignores individuals.

If business wants to try to develop still another period of management—the period of democratic management—I offer as a slogan, Ruskin's immortal line: "There is no wealth except life."

Industrial FIRES *and* EXPLOSIONS *From* ELECTROSTATIC ORIGIN

By ROBIN BEACH

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MANAGEMENT'S PROBLEMS IN ELECTROSTATIC SABOTAGE

STATIC electricity in industry constitutes an ever-menacing problem to management, production, and personnel. Industrial organizations commonly find themselves defeated and helpless under its repeated attacks of sabotage.

This situation results quite generally from a combination of several causes: (*a*) Lack of knowledge regarding the basic concepts of industrial electrostatics and the fire and explosion potentialities of flammable products; (*b*) unawareness of the lurking dangers arising from industrial operations wherein static electricity is generated; (*c*) failure and inability to apply proper safety directives and precautionary controls; (*d*) reluctance to engage the consulting services of an authority on industrial electrostatics to conduct quantitative surveys and apply effective control methods; and (*e*) laxity in training operators and supervisors regarding the need for and methods of maintaining control facilities effective after once installing them.

Those fundamental elements which are basic to an effective safety program within industry and which relate to the behavior of static electricity throughout hazardous industrial locations are presented. In this paper the basic characteristics of flammable products and their susceptibility to generating static electricity are described, causes of electrostatic hazards are discussed, control techniques for the mitigation of these hazards are indicated, and illustrations are cited of the principles as they apply to practice. For obvious reasons only a few of the major phases of electrostatic hazards have been selected.

THE EXPLOSION TRIANGLE

For any fire to start or explosion to occur, the concurrent existence of three basic components within the same space is essential. These three primary components are displayed graphically in Fig. 1 by the triangle whereon the three vertices are labeled fuel, oxygen, and ignition.

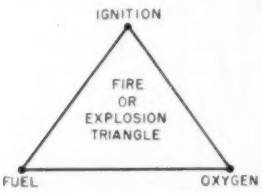

FIG. 1 THREE ESSENTIAL ELEMENTS FOR STARTING A FIRE OR AN EXPLOSION CORRELATED BY TIME AND SPACE BOUNDARIES

The fuel component most commonly exists in vapor, gas, or dust form and it is called the flammable product. The oxygen component is generally supplied from the ambient air, although certain instances exist, such as in the application of anesthesia to patients, where pure oxygen rather than air sometimes possesses specific advantages. The ignition component may occur in the form of electric or percussion sparks, an open flame, a heated surface, or other such competent producing causes.

If any one of these three primary components is lacking, a fire cannot start. Once started, however, a fire becomes self-sustained, as long as it is provided with an adequate and continuing supply of fuel and oxygen.

FLAMMABLE MIXTURES

Liquid fuels, themselves, do not burn. This statement may be impressively verified by energizing from an electric induction coil a spark plug which is immersed in liquid fuel. Only fuel gases or the vapors from liquid fuels burn, and then only when they are proportioned properly and admixed with air to provide the required oxygen.

If air is mixed with fuel vapor or gas into proportions for a flammable or explosive mixture, the mixture may be ignited readily and caused to burn by applying a source of adequate heat energy. The amount of heat energy required to ignite an explosive mixture of fuel vapor and air is remarkably small. The heat energy in an electrostatic spark as commonly experienced by an individual from his finger tips to a door knob, for example, quite generally ranges from 50 to 1000 times more than the threshold energy necessary to just cause ignition.

The lower explosive limit of a flammable mixture is that percentage volume of the fuel vapor or gas in air which is the leanest mixture that will burn. The upper explosive limit is that percentage of fuel vapor or gas by volume with air which is the richest mixture that will burn. The explosive range lies between these two percentage limits.

To illustrate, the hydrocarbon families of liquid or gas fuels possess explosive ranges quite generally within about 1 to 8 per cent by volume. Hydrogen has an explosive range of 4.1 to 74.2 per cent; ethylene oxide 3 to 80 per cent; and carbon disulphide 1 to 50 per cent. For metallic and organic dust clouds, minimum explosive concentrations occur as low as 0.020 oz per cu ft for magnesium and even lower for rosin at 0.015 oz per cu ft.

A list of 609 flammable products has been published (1)[1] which gives not only the explosive limits but also the flash-point, autoignition, melting-point and boiling-point temperatures, as well as specific gravities and vapor densities. This bulletin is an indispensable aid to those interested in studying the potential causes of fires and explosions in industry.

For the purpose of illustrating the application of upper and lower explosive limits of flammable liquid products, Table 1 has been prepared to include the per cent explosive range of the product by volume with air, the volume of vapor yielded per gallon of product when fully evaporated at room temperature, and the volume of flammable mixture thus formed with air at the lean and rich ends of the explosive range.

Fires occur only when the ignited flammable mixture occupies but a small portion of the enclosed space. On the other hand, explosions take place when the ignited flammable mixture pervades the entire enclosure. The ignition of flammable mixtures results most commonly from sparks which originate from high potentials of static electricity.

Contributed by the Safety Division and presented at the Annual Meeting, New York, N. Y., November 30-December 5, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

TABLE 1 VOLUMES OF VAPOR AND EXPLOSIVE MIXTURES PER GALLON OF FLAMMABLE LIQUID

Flammable liquid	Explosive limits, Per cent by vol in air — Lower	Upper	Cu ft of vapor per gal	Cu ft of explosive mixture — Leanest	Richest
Acetone	2.15	13.0	44.0	2047	339
Benzene	1.4	8	35.3	2521	442
Benzine (petroleum ether)	1.1	4.8	15.8	1436	329
Carbon disulphide	1.0	50	32.5	3250	105
Diethyl ether	1.7	48.0	30.9	1820	64.4
Ethyl alcohol	3.28	19	55.2	1680	290
Gasoline	1.3	6	23.8	1830 (approx)	397
Hexane	1.25	6.9	24.7	1975	358
Methyl alcohol	6.0	36.5	79.2	1320	217
Methyl ethyl ketone	1.81	11.5	36.0	1990	313
Octane-n	0.84	3.2	20.3	2440	635
Styrene	1.1	6.1	28.0	2544	459
Toluene	1.27	7.0	30.6	2406	437
Xylene	1.0	6.0	26.7	2670	445

The threshold energy required in sparks to just ignite many of the explosive vapor or gas mixtures is so small as to confound the imagination. For many of the hydrocarbon and other vapor-air mixtures, the threshold spark energy of ignition lies in the order of 0.1 to 0.3 millijoule. This heat energy is about one millionth of the electrical energy which passes through a lighted 100-watt incandescent lamp bulb in 1 sec.

Some ignition-spark energies of flammable vapor-air mixtures, as determined by the meticulous measurements of P. G. Guest and associates at the U. S. Bureau of Mines in Pittsburgh (2), are shown in Fig. 2. The paraffin-series hydrocarbon products, shown in the upper part of Fig. 2, are observed to possess almost identical minimum values of ignition energy, despite the wide variation in their numbers of carbon atoms which range from one for methane to seven for heptane per molecule. In the lower part of Fig. 2 dissimilar products are compared in which the products of each chart possess the same number of carbon atoms per molecule and here, too, the ignition energies are almost identical.

In instances where the vapors of flammable products, such as hydrocarbons and ether, have been mixed with pure oxygen rather than with air, minimum spark-ignition energies in the order of 0.002 millijoule have been indicated.

FIRES, EXPLOSIONS, AND DETONATION

As already mentioned, fires occur from the ignition of localized volumes of explosive mixtures. These sometimes culminate in extensive and costly fires but many are controlled in their incipiency. The fire loss in this latter instance consists of the cost of the damaged product being processed, the cost of spent fire-extinguishing agents, repair charges for damaged machines, and the cost of lost time for and, on occasions, injuries to operating personnel.

On the other hand, when the explosive mixture pervades the working space and ignition results, the flame front in normal combustion progresses more or less spherically, except as modified by boundary conditions. The rate of flame progression varies from 1 or 2 fps or more, for most of the flammable products up to a maximum for hydrogen of about 7 fps. The expansion of the burned products and the heated air in the range of the most effective mixture, that is, the stoichiometric mix-

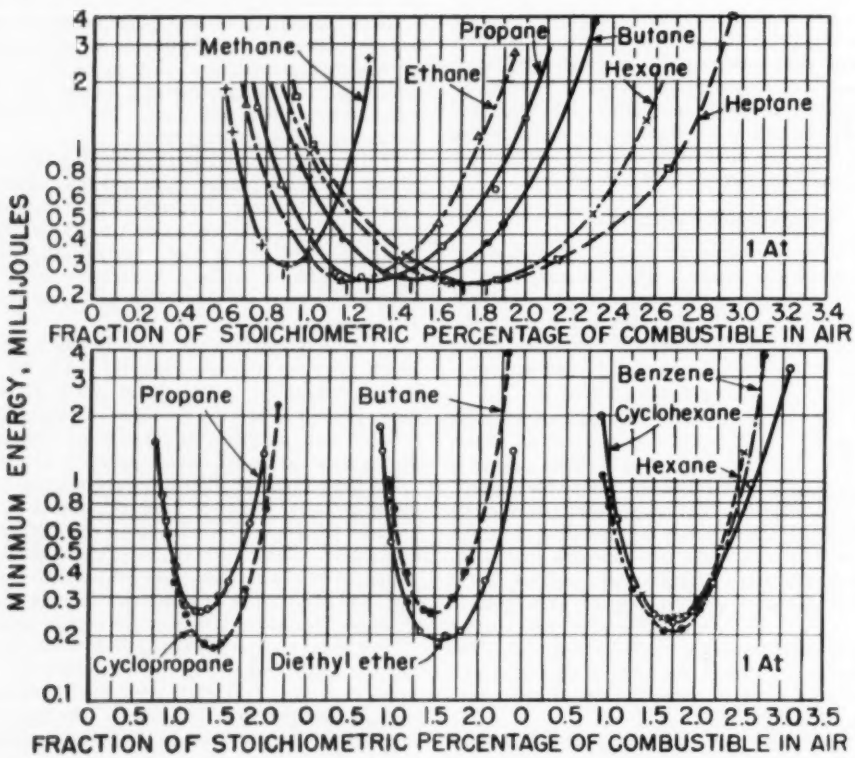

FIG. 2 MINIMUM IGNITION ENERGIES OF COMBUSTIBLE AIR MIXTURES IN RELATION TO STOICHIOMETRIC PERCENTAGE IN AIR

ture for perfect combustion, develops maximum pressure against the containing walls of the room—a value which lies in the order of 100 psi.

Such explosions sometimes are characterized by strange and inconceivable vagaries, such as blowing out steel structures between rows of adjacent windows, damaging other buildings by forces transmitted through long and curvilinear corridorways, and the like. Windows which comprise a large percentage of wall areas in modern industrial buildings seem to provide insignificant venting facilities from such explosive forces. This anomalous situation results from the very rapid rate of rise of pressure which starts demolition of structural parts before breaking windows can vent the explosive forces.

Dispersion products, commonly called dusts, comprising metal dusts, organic dusts from cereal, flour, sugar, chocolate, wood, grain, and from innumerable other such processing operations, all constitute potential sources of explosions. The minimum explosive concentrations of many such dispersions on the average extend approximately from 0.015 to 0.2 oz per cu ft of air for particle size in fineness of about 200 mesh or less. The threshold energy of ignition is high compared to vapor or gas mixtures, although it becomes less as particle size decreases, as can be seen in Fig. 3. The ignition energy lies quite generally

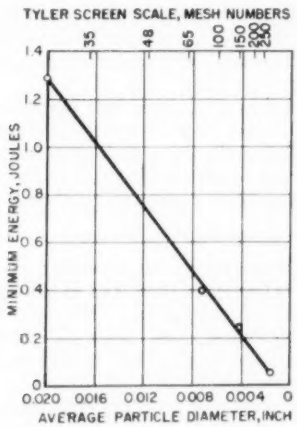

FIG. 3 EFFECT OF FINENESS ON MINIMUM ENERGY REQUIRED FOR IGNITION OF DUST CLOUDS OF CELLULOSE ACETATE MOLDING POWDER (M-C-1) BY ELECTRIC SPARKS

in the order of 10 millijoules to 100 millijoules and hence substantial static electric sparks are necessary to ignite such mixtures. The maximum pressures developed from explosions of dispersion products quite generally lie in the order of 30 to 120 psi.

Some flammable vapor and gas products, and little is as yet known what factors determine these, undergo detonation after ignition of the explosive mixture has taken place. The detonation range lies quite generally about midway within the normal explosive range. When detonation develops after normal combustion starts, the velocity of the flame front rapidly accelerates from flame speeds of a few feet per second to thousands of feet per second—the maximum being in the order of some 12 times the normal velocity of sound, or approximately 4000 meters per sec. The pressures thus developed have attained maximum values of about 10,000 psi in the radial direction of flame propagation. Some of the worst detonating explosions have occurred in industries using premixed acetylene gas and premixed manufactured gas with hydrogen enrichment. Explosions where detonation has developed generally can be determined at a glance by observing the destructive consequences to foundation walls, reinforcements, and structural members.

HOW STATIC ELECTRICITY IS GENERATED

Electric charges, which constitute static electrification, invariably occur in pairs of positive and negative kind; they are the electrostatic twins. Electrification is developed when any two dissimilar substances make contact. The negative charges, electrons, migrate from the surface molecules of one substance to those of the other substance, thus imparting negative electricity to the substance receiving the electrons. The positive counterparts in equal numbers, called positive ions, remain in the surface of the first substance as crystal-latticed molecules which have lost one or more electrons by migration.

The number of electric charges thus developed in the two contacting substances depends on the physical and chemical nature of the two substances, their temperature, the extent of their areas in actual contact, the cleanliness of the contacting substances, and the pressure pressing them together. Friction is not necessary in the generation of static electricity, although in fibrous substances friction may appreciably increase the electrification.

If one or both of the two contacting substances possess insulating qualities, then when they are separated, the electrons are impounded on the substance to which they migrated and the two substances thus become oppositely electrified (3). When the electrified substances are separated, the difference of potential which may arise between them can attain values ranging from a few thousand volts to many millions of volts.

A few common examples of the generation of static electricity in various phases of industry are cited here as illustrations. These are as follows: 1, Raw materials being processed through various types of machines in the producton of yarns and of textile products from yarns; 2, the manufacture of paper web and the processing of paper into bags, newspaper, and commercial and industrial paper of a wide variety, as well as all forms of printing, cutting, folding, waxing, and other special operations; 3, the many processing stages in the manufacture of an almost infinite variety of rubber products; 4, the manufacture of innumerable forms of plastic products, such as yarns, fabrics, sheets, films, and tubing; 5, the refining of petroleum into its many industrial products, as well as the vast varieties of industrial solvents and chemicals, such as hydrocarbons, ketones, esters, ethers, alcohols, nitrogen compounds, organic chlorides, sulphides, and the many other liquid and gaseous compounds; 6, the manufacture of a wide variety of dispersion products, as well as the coincidental formation of organic and metallic dusts as industrial by-products; 7, the operation of aircraft, especially high-speed all-metal airplanes in flying through rain, fog, snow, ice crystals, smoke, and dust; 8, the rolling of rubber tires of automotive vehicles along roadways of all types; 9, the flowing of nonconductive liquids through pipes and hose lines into and out of storage tanks, tank cars, tank trucks, marine tankers, processing tanks, kettles, reactors, and mixers, many of which are lined with glass, porcelain, or ceramics; and, 10, the application by various techniques in administering anesthetics to patients who are undergoing surgical operations or treatments.

Nonconductive products, such as textiles, paper, rubber, and plastics, in passing over or between steel rolls or drums during the many types of processing in manufacture, generally acquire from the steel surfaces vast numbers of electrons. Hence for the most part, these products are electrified to negative polarity. When they are electrified to about 30 kv, for example, while being processed, the number of electrons which are commonly acquired by each square inch of surface ranges within the order

of one hundred billion electrons. Similarly, gasoline and the many varieties of other nonconductive industrial liquids and solvents in flowing through steel pipes or rubber hose, likewise, commonly become negatively electrified (4).

In general, a substance which possesses the higher dielectric constant, when in contact with a substance of lower dielectric constant, passes electrons to the latter, thus imparting to it negative electrification. Table 2 shows the magnitude Q,

TABLE 2 TEST DATA SHOWING CONTACT ELECTRIFICATION

Specimen no. 1	Specimen no. 2	K_1	K_2	Q_{1-2} esu/cm²
Crown glass.....	Steel	6.7	3.1	+15.8
Flint glass.....	Steel	7.8	3.1	+20.9
Quartz.....	Steel	4.6	3.1	+ 7.1
Fluorite.....	Steel	6.9	3.1	+16.0
Fluorite.....	Quartz	6.9	4.6	+ 9.3
Crown glass.....	Flint glass	6.7	7.8	− 5.1
Crown glass.....	Quartz	6.7	4.6	+ 8.2
Quartz.....	Flint glass	4.6	7.8	−16.2
Flint glass.....	Flint glass	7.8	7.8	≈ 1.5
Ebonite.....	Steel	2.8	3.1	−18.6

and the polarity of electrification by contact of one optically flat substance with another (5), in which the dielectric constants are also listed.

The dielectric constants of various grades of steel generally lie within the range of 3 to 5. Hence electrons commonly migrate from steel to such substances as textile, paper, and rubber stock, and many of the plastic products of lower dielectric constants than steel—thus electrifying them to negative polarity.

On the other hand, the aluminum foil of airplanes in flight through the various phases of distilled water in the form of fog, rain, snow, and ice crystals acquire high negative electrification (6). Since distilled water possesses a dielectric constant of 81, its atmospheric phases, by contacting the metal surfaces of airplanes, impart to the airfoils unusually high electrification of negative kind.

DEVELOPMENT OF HIGH VOLTAGE

Once the positive and negative charges in equal numbers have been acquired by the two contacting substances, a charged electrical capacitor has been formed. Its capacitance is directly proportional to the areas of the electrified surfaces and inversely proportional to the separation of these surfaces.

If the capacitance is designated as C, the electrification charge as Q, and the voltage as V, these three basic factors are related by the equation $V = Q/C$. If the electric charge Q is considered constant, this equation states that when the capacitance C is greatest, the voltage V between the two oppositely charged areas is least and this situation prevails when the two substances are in so-called contact.

Conversely, as separation of the oppositely charged areas occurs, the capacitance decreases and the voltage increases. In this manner voltage increases as paper, fabric, rubber, or plastic sheets separate from the metal rolls of processing machines. If the stock is highly insulating, or so-called dielectric, little or none of the electric charge leaks away, and the voltage for a given distance of separation is maximum.

The speed of any given dielectric stock in passing through a processing machine determines to some extent the leakage of electric charge. The higher the processing speed the higher becomes the voltage. As stock separates from a metal roll of the machine where the electrification occurs, each charged unit area of the stock moves away from the roll, its capacitance decreases rapidly at first, and the voltage between the charged unit area and the grounded metal roll rapidly increases.

Finally, relatively large changes in the distance of separation of a charged unit area of stock from the metal roll causes practically little, if any, change in the capacitance and hence the voltage approaches a constant value. This pattern of behavior of the voltage variation between electrified stock and ground for two widely spaced idler rolls is shown in Fig. 4. The

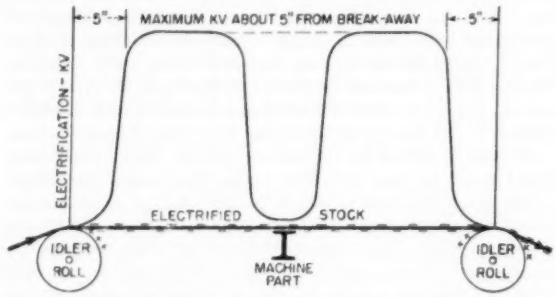

FIG. 4 VOLTAGE CHARACTERISTIC OF ELECTRIFIED DIELECTRIC STOCK BETWEEN TWO ROLLS MODIFIED BY HIGH-CAPACITANCE GROUNDED MEMBER

dip in the middle of the voltage curve results from a localized increase in the electrical capacitance of the charged stock because of a structural machine member being located close to the electrified stock.

Voltages created in this manner may range from a few thousand volts in rubber or plastic-coating operations on fabrics to a few hundred thousand volts in high-speed newspaper printing or the calendering of plastic films (7). Sparks 10 to 15 in. long are not uncommonly encountered in these latter operations.

ELECTRIFICATION BY INDUCTION

Another insidious source of generating static electricity, which creates "mysterious" fires and explosions in industry, relates to electrostatic induction. This type of electrification occurs commonly out of doors, from the effects of electrified clouds and especially from so-called "thunderheads."

Assume a tank truck, for instance, parked on a dry concrete area during the passing of a heavily electrified cloud and that the underside of the cloud is charged with positive electricity. The powerful electric field between the cloud and earth attracts electrons from earth onto all elevated objects, and hence electrons pass slowly and with difficulty through the dry concrete and rubber tires to the chassis and shell of the tank truck (8). Because of the particularly high electrical resistance of dry concrete which may be more than a million times higher than that of the rubber tires, perhaps an hour or more is required for the complete electrification of the shell of the tank truck by this gradual migration of electrons from the earth.

Induced electrification and its hazards, as for the tank truck, may apply similarly to frame buildings with ungrounded metal roofs, to ungrounded tanks, to wire fences using wood posts, and to a wide variety of other expansive, insulated, metal structures. Thus barns have been set on fire, airplane engines have been caused to misfire and stop, automobile engines have been influenced in a similar manner, radio broadcasting has been "blacked out" by radiation interference, and many other malfunctions have been caused.

If insulated metallic structures are grounded thoroughly, all hazards of potential spark ignition and electric shocks from these otherwise electrified sources are eliminated; some malfunctions mentioned also are corrected. The importance of such grounding precautions in controlling hazards from electrostatic induction cannot be overemphasized.

CONTROL OF ELECTROSTATIC HAZARDS

In a few specialized areas of industry where hazardous electrification occurs to processed nonconductive stock, various types of conventional electrostatic neutralizers are available for controlling the accumulation of static electricity and thus for eliminating spark hazards. The types of industrial service to which these electrostatic neutralizers apply, in particular, are certain phases of process manufacturing of paper, textiles, rubber, and plastics. Some of the several hazardous operations within these industries include calendering, printing, cutting, folding, cementing, coating, spinning yarn, and processing various other specialized products.

The many electrostatic neutralizers which currently are available on the market for controlling static electricity in the manufacturing or processing of nonconductive stock within the four fields cited, are classified as: 1, preionizing neutralizers; and, 2, induction neutralizers.

During the past year the author conducted a pioneer investigation into the properties and characteristics of all static neutralizers on the market and the paper describing the results of this study is the only published treatise on this subject (9). In addition to explaining the basic principles of neutralizer equipment, the author included (*a*) the classification of electrostatic neutralizers; (*b*) an appraisal of their degrees of inherent safety; (*c*) their relative advantages and limitations; and, (*d*) the test data of their comparative ionizing and discharging characteristics.[2]

Let it be again emphasized that all electrostatic fire and explosion hazards in industry can be controlled to their virtual elimination.

For comprehensive investigations and adequate controls to be completely effective, the services of one are required who is qualified in the technology of industrial electrostatics by virtue of specialized training, broad field experience, and research facilities.

No palliatives or proprietary "cure-alls" for general application to the electrostatic ills of industry can be applied with better prospects for success, here, than in trying to cure human ills without the scientific methods of the experienced physician in the use of his techniques of diagnosis, analysis, and prescription.

The costs of conducting a quantitative investigation of electrostatic fire and explosion hazards in an industrial plant and of applying appropriate mitigating agencies and techniques, tailor-made to fit best the particular need of the industry, are insignificantly small in comparison with the direct and the indirect annual savings which can be realized from the investment.

TYPICAL ELECTROSTATIC PROBLEMS IN INDUSTRY

The variety of problems resulting from static electricity within the various domains of industry, other than the paper, textile, rubber, and plastics industries, is also legion. In the interests of clarifying some of the various principles which have been presented, as well as of bringing closer to home a few of the "hot spots" within industry, a few typical instances of industrial hazards caused by static electricity are cited.

Petroleum Industry. Electrostatic hazards particularly abound throughout the petroleum industry. Fires and explosions occur in the innumerable phases of manufacturing processes, transportation, storage, distribution, and the utilization of the many flammable products. Calamitous fires and explosions from electrostatic origin in these industries have occurred at manufacturing plants, storage tanks, tank-car sidings, loading racks of bulk stations, consumers' stations and plants and, also, in transporting these products by pipe lines, tank trucks, and tanker service, during loading or unloading of cargoes from the latter at docks or off shore.

The author has been called into numerous investigations relating to explosions, and establishing safe practice against future explosions, in the loading or unloading of kerosene, fuel oils, and crude oil from barges, tankers, tanks, and drums. Because the flash-point temperatures of these products are high in comparison with normal ambient temperatures, many of the precautions used in the safe handling of highly volatile, low-flash-point products, such as gasoline, benzene, and the like, seem to be abandoned.

All such explosion hazards can be controlled and virtually eliminated by the rigorous adoption of advised techniques in loading and unloading operations and the purging of tanks with precautionary methods which are safe, simple, and economical.

Chemical Industry. In the chemical industry, many areas of manufacture utilize large quantities of flammable components in liquid and gaseous states. Reactors for converting raw materials into commercial products comprise a variety of vacuum or pressure vessels, kettles, tanks, mixers, and stills. Some of these reactors operate at atmospheric pressure. This equipment may be constructed variously of metals appropriate to the nature of the products and processing operations. Vessels may be lined with glass, porcelain, or a variety of ceramics. Also the piping may be composed of metal or the metal may be lined with insulating and protective or sterile coatings like the reactor vessels. The pipes also may be made of glass, Pyrex, ceramics, and other insulating compositions, the sections of which are held together with lined metallic couplings and with lined valves.

Sometimes where insulating liners of vessels or of pipe lines are employed, the electrification is not capable of discharge. Under such conditions the alternative method is one of not trying to discharge the static electricity but rather of maintaining a safe atmosphere where sparks may occur. This method is safer and a more feasible resolution of the dilemma and it is a technique which the author has used successfully in numerous resolutions of hazardous problems. In the filling stages of operating vessels and reactors in hazardous processes, the explosive potentialities are hereby prevented while the accumulating flammable vapors pass through their explosive range where air is present.

Dispersion Industry. The dispersion industry and the many other industries in which organic and metallic dusts inherently are produced are subject to particularly dangerous conditions where electrostatic sparks may occur. As these finely divided air-borne dusts commonly pervade the enclosure wherein they are created, then if ignition occurs, an explosion rather than a fire results. The finer the particle sizes of dust dispersion the more nearly the dust approaches the properties of vapor in providing flammable mixtures. Some of the most devastating explosions within industry have thus occurred.

The record of the number of dust explosions in the United States to April 1, 1946, as reported to the NFPA (10) but which excludes dust explosions in mines and ordnance plants, indicates that 888 explosions occurred, 575 people were killed and 1364 injured, and $79,469,778 were lost to industry. Of course, the two excluded industrial areas, mines and ordnance plants, are known to be large and gruesome contributors to explosion casualties and losses, probably well overshadowing the aggregate of all other industries in regard to injuries and deaths of personnel, as well as to total loss from destruction of property.

[2] Limitations of space do not permit even a summary of this comprehensive dissertation, as the citation of the salient features of this paper, alone, constitutes a major presentation. A summarized presentation entitled "Electrostatic Neutralizer Discharge and Safety Characteristics," appeared in *Electrical Engineering*, April, 1952.

TABLE 3 DUST-EXPLOSION CHARACTERISTICS OF VARIOUS POWDERS

Type of powder	Ignition temperature of dust cloud, deg C	Minimum spark energy required to ignite dust cloud, millijoules	Minimum explosive concentration, oz per cu ft	Maximum explosion pressure, psi	Rates of pressure rise, lb/sq in./sec		Limiting oxygen percentage to prevent ignition of dust cloud by electric sparks
					Average	Maximum	
Zirconium	[a]	15	0.040	50	1450	5000	[b]
Magnesium	520	20	0.020	72	4400	4750	[b]
Aluminum	645	20	0.035	89	2150	5700	3
Titanium	480	..	0.045	52	750	1650	[b]
Rosin	390	10	0.015	56	1250	3000	14
Phenolic resin	500	10	0.025	61	1350	3150	14
Polyethylene	450	80	0.025	83	400	1250	15
Allyl alcohol resin	500	20	0.035	68	1750	3550	..
Cellulose propionate	460	60	0.025	66	1350	2350	..
p-Oxybenzaldehyde	430	15	0.020	58	2150	3150	..
Hard rubber; crude	350	50	0.025	57	850	3350	15
Coal	610	40	0.035	46	350	800	16
Sulphur	190	15	0.035	41	700	1950	11
Phenothiazine	540	..	0.015	43	600	1450	16
Cornstarch, modified	470	40	0.045	72	1050	2150	..
Soap	430	60	0.045	60	660	1300	..
Aluminum stearate	400	15	0.015	62	750	2100	..

[a] When zirconium powder was dispersed into air at room temperature it ignited under some conditions, apparently through static electric discharge between particles in dust cloud.

[b] Oxygen-reduction tests were made in air-CO_2 mixtures. Dust clouds of zirconium, magnesium, titanium, and certain magnesium-aluminum alloys ignited in pure CO_2.

To illustrate the properties of dust explosions, consider fuel pitch and coal dust. When fuel pitch is finely pulverized to pass through a 200-mesh sieve, the lower explosive limit of the air-diffused pitch dust lies between about 0.040 and 0.050 oz per cu ft (11). A maximum explosive pressure may be expected in the order of 30 psi and the concentration of dust to produce this maximum pressure lies within the range of 0.09 to 0.10 oz per cu ft. The lower explosive limit for coal dust lies between about 0.04 and 0.07 oz per cu ft. For either fuel pitch or coal dust, a dilution of over 70 per cent incombustible dust is required to inhibit the propagation of flame.

Metal dusts, such as, for example, magnesium, aluminum, zinc, ferromanganese, silicon, and many others, in the order of 200-mesh fineness, more or less, can become as for fuel dusts highly electrified, create sparks, and burn or explode (12). The explosion characteristics of a few illustrative metal and organic dusts are given (13) in Table 3.

The control of static electricity throughout this entire field of dispersion products may be resolved by appropriate study into specific phases of the offending problems, each resolution differing radically from one type of manufacture to another.

Airport Hazards. Electrostatic hazards at airports occur on every hand and their controls require constant and unfailing vigilance. Some of the hazards at airports arise from (*a*) the movement of any rubber-tired vehicles, including the landing and taxiing of airplanes, on concrete or black-top runways, aprons, and ramps; (*b*) the fueling operations of airplanes by tank trucks; (*c*) ill-advised methods and techniques utilized in fuel-distributing operations; (*d*) baggage loading and unloading of airplanes; (*e*) improper or no grounding facilities; (*f*) the electrification of airplanes on aprons by dust-laden breezes, by the blowing of dry snow, or by induction from electrified clouds; and (*g*) innumerable operations within hangars and service shops in which static electricity is generated.

These sources of electrostatic hazards are all capable of control and with this objective the Aviation Committee of the National Fire Protection Association has presented a code of practice for airport safety from electrostatic hazards.

Electrification of Airplanes. Probably no one industry has attempted more diligently than aviation to control static electricity—in this instance on aircraft in flight. It has had extensive recourse to financial support; and it has utilized to a marked degree the virtues of co-operative effort. The combined accomplishments of the many individual and group research projects have provided a wealth of information regarding the properties of electrostatic generation, accumulation, and ionization on aircraft.

In the wake of these attempts to resolve electrostatic problems—the hazards of which result annually in many casualties and deaths—an amazing number of patents have been granted for control devices and systems, almost all of which are inapplicable, impractical, self-hazardous, and lacking quite generally in the application of scientific principles and aerodynamic conventions.

Throughout aviation, in private, commercial, and military flying, outstanding electrostatic hazards to safe flight are still old ones (14). Among these hazards (*a*) radio blackouts still occur; (*b*) radio navigation instruments still fail; (*c*) airplane engines still explode in mid-air; (*d*) baggage and tail compartments still catch on fire or explode; (*e*) tire blowouts at landing still take place; and (*f*) engines still become "rough" from spark-pitted bearings which require prompt overhaul.

A British firm in developing a superior system of air navigation utilizes a flight instrument on airplanes which is influenced to a critical degree by the presence of static electricity. When radio black-outs occur, the needle of this instrument rotates rather than moves normally in indicating correctly gradual departures from on-course positions of the airplane. In trying to correct this instrumental aberration as well as to preserve the use of its navigational system, the company attempted every known means, then available, for discharging the detrimental electrification of the airplane, including the Army-Navy wick dischargers, but all to no avail. Finally this seemingly insurmountable problem was resolved effectively by installing sharp-pointed, multiple-bristle, electrostatic ionizers on the tips of the wing and empennage structures and, also, on the propeller blades.

CONCLUSION

Predicated on the science and technology of industrial electrostatics, supplemented by extensive experience in research service and field investigations relating to the resolution of electrostatic problems in many types of hazardous industries,

several correlative comments are indicated which are included here for the reader's reflection and consideration.

1 Electrostatic fire and explosion hazards, as well as many kindred problems throughout industry, are all capable of resolution and control to the extent of their virtual elimination.

2 In undertaking a program for controlling the subtle sabotage and destructive behavior of static electricity, success can be anticipated only by the full support of management, not only in providing adequate working funds, but also in displaying genuine interest in results.

3 A comprehensive survey for controlling electrostatic hazards within an industry presupposes the techniques of thorough quantitative investigation of each hazardous operation.

4 After devising and utilizing applicable test techniques, the appraisal and interpretation of the correlated technical information presuppose its effective use through applying the exact knowledge of electrostatic principles as these relate to the specific problems and, also, the benefits from specialized experience in disclosing unique vagaries and the obscure behavior of certain phases of electrification.

5 Except for the restrictive areas of paper, textile, rubber, and plastics manufacture in which conventional static neutralizers may be utilized more or less effectively in certain instances, no so-called cure-alls are otherwise applicable to the electrostatic problems throughout the length and breadth of other industries, and hence unique tailor-made resolutions of these problems are the only recourse.

6 By installing correctly applied antistatic controls of either the "ready-made" or the tailor-made varieties to electrostatic hazards and kindred problems, many industrial processes can be materially accelerated, production increased, costly spoilage reduced, unpleasant and sometimes harmful humidification systems abandoned, production costs decimated, operating expenditures substantially curtailed, and personnel injuries and deaths practically eliminated.

7 The costs of a comprehensive survey of the various electrostatic problems in any industry and of the application of effective antistatic controls have proved insignificantly small in comparison with the annual savings realized from the investment.

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Electronic Flowmeter

A METHOD for measuring flow by means of a new type of electronic flowmeter has recently been developed at the National Bureau of Standards. Capable of measuring the air currents in a still room or the rapid flow of fluids in pipes, this device utilizes the change in velocity of sound waves as a measure of fluid flow. It is said to have a very fast response and does not obstruct the fluid currents to make the measurement. In addition, the signal-to-noise ratio is sufficiently high to permit the measurement of extremely small velocities.

Most of the present methods for measuring the velocity of flowing liquids depend on mechanical devices that usually introduce discontinuities in the fluid and have inherent inertia which prevents faithful reproduction of fast velocity changes. One type of flowmeter utilizes the principle of the homopolar machine; but this method cannot be used for gases, and the instrument is, at present, restricted to the measurement of conductive fluids. Another method makes use of the resistance change in hot wires placed in the path of fluid flow. However, besides presenting an obstruction to the flow, the hot wire is not generally applicable to fluids that would change chemically or physically as a result of the heat from the wires.

In the NBS flowmeter, a sound wave is transmitted over a fixed distance through the flowing fluid, and the phase of the received wave is compared with that of the transmitted wave. The sound energy is imparted to and taken from the fluid through the walls of the containing vessel. No part of the measuring system need come in direct contact with the medium under study. This characteristic of the system makes the unit applicable to the measurement of blood flow in the aorta or for the detection of the flow of chemicals in a closed system, for example, the coolant in a chain reactor. Minor modifications will permit the measurement of the flow of such fluids as gas or oil in a metal pipe, or a determination of the relative velocity of a ship to that of the water through which it is moving.

In instances other than those involving extremely high velocities, i.e., in wind tunnels, a simple system utilizing merely a stationary device to transmit energy into the medium and another stationary unit to receive it would be impractical because changes in distance or propagation velocity would produce errors far greater than the variations due to flow. For this reason the transmitter and receiver of the new flowmeter are exchanged periodically without varying their locations. This is accomplished by using identical magnetostrictive or piezoelectric exciters, such as barium titanate crystals, as transmitter and receiver and by switching their connections alternately to the receiving and transmitting channel. Thus the phasemeter displays two phase shifts alternately, one a function of the sound velocity plus the fluid flow and the other a function of the sound velocity minus the fluid flow. The difference between the two phase shifts is a measure of the velocity of the fluid. The switching can be made to operate faster than the inherent variations occurring in either the transmitter, receiver, or even the medium. Hence the variations will occur at a minimum of one complete transmitter-received switching cycle, and the phase difference will remain unaffected.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

J. J. JAKLITSCH, JR., *Technical Editor*

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Engineering-College Enrollment

THE engineering-college-enrollment picture for the fall of 1952 was extremely encouraging, according to a report in the *Journal of Engineering Education*, February, 1953, by Robert C. Story and Henry H. Armsby of the U. S. Office of Education. After successive yearly declines from the high point of 244,390 in 1947, engineering enrollment has taken a decided upward turn, the report notes. The 158,518 students currently enrolled in engineering schools accredited by the Engineers' Council for Professional Development represent an increase of 7.3 per cent over the number enrolled in the fall of 1951. The increase in total enrollment in all higher educational institutions for the same period was 1.5 per cent. Since engineering enrollment is made up almost exclusively of men, it is perhaps more appropriate to contrast the 7.3 per cent increase in engineering enrollment with the 0.8 per cent decrease in total male enrollment in all higher educational institutions.

Colleges and universities across the nation experienced increases in new students this fall unparalleled since the tremendous wave of new students in the fall of 1946. In the engineering schools the percentage increase in new students was more than twice what it was for all institutions (34.3 against 13.7). The 1952 freshman class, numbering 45,854, is the fourth largest class ever to enter the engineering schools. Only in 1946, 1947, and 1948 has the number been exceeded.

This year 8.5 per cent of all freshmen were enrolled in engineering schools as compared to 7.2 per cent in 1951 and 5.7 per cent in 1950. The prewar figure was about 8 per cent. The elements which are probably most closely related to the selection of engineering by so many freshmen are: (1) The widely publicized need for technical and scientific personnel, and the relatively high rates of pay new engineering graduates are receiving, (2) the opportunity for military reserve training with attendant commissions upon graduation, and (3) the fact that postponement of military service until graduation is more socially palatable in the case of scientific and technical training than in other areas of study.

The large increase in the number of freshmen engineering students enrolled last fall will have a decided effect on the trend in the number of graduates. Assuming normal progression, this year's entering class will yield about 29,000 graduates in 1956. In the intervening years, however, the number of graduates will continue to drop, reaching a low of somewhat less than 20,000 in 1954. The present shortage of civilian engineers is apt to grow more acute in the years immediately ahead as fewer and fewer engineering students complete their training, the report states. Moreover, it should be remembered that many of those who do graduate will be going directly into the military service.

The number of undergraduate engineering students has increased for the first time since 1946. The 138,170 enrolled in the fall of 1952 represent an increase of 7.6 per cent over the previous year's enrollment.

Of the undergraduate enrollment, freshmen account for 33 per cent; sophomores, 19 per cent; juniors, 16 per cent; and seniors, 17 per cent. About 2 per cent are fifth-year students in five-year curricula, and the remaining 13 per cent are part-time and evening students. The latter category of students has increased steadily as the composition of the student body has changed from predominantly veteran students to non-veteran students.

About 55 per cent of all undergraduate engineering students are enrolled in three curricula—mechanical, electrical, and civil. Of these three, 21.2 per cent were enrolled in mechanical, 19.3 per cent in electrical, and 14.7 per cent in civil. The tendency of institutions not to assign freshmen to specialized curricula is increasingly reflected in the current statistics. In the fall 92 schools reported unclassified students as compared to 84 schools in the fall of 1951.

The number of male students who received their undergraduate engineering degrees in 1951–1952 is down 28.3 per cent from the previous year. This compares with the decline of 18.7 per cent in first degrees granted to male students in all institutions. Of all first degrees granted to men students 11.9 per cent were in engineering. In the previous year 13.5 per cent of all first degrees to men were in engineering.

The distribution of first degrees among the three principal engineering curricula was as follows: Mechanical, 6823; electrical, 5876; and civil, 4917. The number of graduates in each of the three curricula is considerably lower than in the previous year. In mechanical engineering the number of de-

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

grees decreased 29.0 per cent. About 32 per cent fewer were graduated in electrical engineering, and 24 per cent fewer were graduated in civil engineering.

The increase in graduate enrollment has continued unabated. In the fall of 1952, 5.9 per cent more students were enrolled for the master's or other predoctoral degree than in 1951. The number of students enrolled as candidates for the doctor's degree increased 1.9 per cent. About 57 per cent of the students working toward the master's degree were evening students. In contrast, a considerably smaller percentage (22.8) of the students working for their doctorates were evening students.

The increase in the number of graduate students is a reflection of the demand of industry for persons with training beyond the baccalaureate degree. This is especially evident when one considers the high proportion of the candidates for master's degrees who are enrolled as evening students. Undoubtedly, most of these students are employed engineers who have recognized the necessity for advanced training either to improve their positions or to better their understanding of the more complex engineering processes which are developing today.

While the number of graduate students in engineering has increased, the percentage of all engineering students who are enrolled in graduate work (12.8) has decreased. In the fall of 1951 the percentage was 13.1. For the college population as a whole, about 10 per cent are graduate students.

More than 30 per cent of all engineering graduate students are taking their training in electrical engineering; mechanical engineering accounts for about 17 per cent; while approximately 11 per cent are enrolled in chemical engineering.

Masters' degrees in engineering declined 19.5 per cent in 1951–1952 from the previous year. The comparable decrease in all masters' degrees conferred was 5.8 per cent. The number of doctors' degrees in engineering remained exactly the same as in 1951, while the percentage increase for all doctors' degrees was approximately five per cent.

Atomic-Energy Report

THE first decade of atomic-energy development by the Goverment of the United States came to a close in the six months covered by the recently issued Thirteenth Semiannual Report of the Atomic Energy Commission.

In more than a symbolic sense, this latest half year has witnessed the crystallization of important lines of exploration, research, and development that began earlier in the decade, the report states.

The high and somber significance of the results of the November tests at the Pacific Proving Ground in the Marshall Islands was noted by the retiring President of the nation in his state of the union message to the Congress in January.

To meet the increased military requirements for national defense, the Congress in July, 1952, authorized the largest addition yet made to the plant for production of fissionable materials and weapons. New uranium discoveries and the development of processes for extracting uranium from low-grade sources made it possible to consider an expansion of this magnitude. Construction started promptly, with ground broken in August and September for the new fissionable materials plants. When construction for which funds have been appropriated is complete, the nation's capital investment in atomic energy will be about $7.5 billion, five times as large as six years ago when the Commission assumed its stewardship.

The development of reactors for the output of power made longer forward strides than in any other half year of the decade. The theory of "breeding" was put under trial at the Reactor Testing Station, and the Materials Testing Reactor also went into operation. Assembly was substantially completed on one prototype reactor for submarine propulsion, and fabrication started on the seagoing version to power the submarine U. S. S. *Nautilus*. Work also began on the prototype of a reactor to power the submarine, U. S. S. *Sea Wolf*. A contract was entered into for developing a reactor to supply power for a large naval vessel such as an aircraft carrier. Work began on a testing facility for prototype nuclear power plants for aircraft.

Highly important for the long pull in the nuclear power field, industrial firms and leaders have evinced a solid and a growing interest in power-reactor development, the report states. This interest was indicated in part by the increasing number of suggestions that the Atomic Energy Act be revised to encourage further industrial activity. These suggestions raise policy issues as atomic-energy development enters its second decade.

The reports from the first round of studies of technical and economic problems of power-reactor development made by four industrial teams have been studied. The AEC staff has been instructed to extract the portions of these classified reports which can be declassified and prepare them for issuance. This will help industrial managements and other interested groups to learn more about the nature of the problems inherent in power-reactor development. One of the four teams, augmented by 11 associated firms, has entered a joint program of research and development with the AEC. A fifth and new team has begun its survey of reactor technology.

Industry's interest in various phases of the atomic-energy program is reflected by the 225 concerns that contacted the AEC's Office of Industrial Development since its establishment last May. The firms were interested in doing research and development for the Commission, starting new businesses based on atomic energy, selling their products to AEC, and getting general and technical information on all aspects of AEC operations.

On the frontiers of nuclear science, the report states, the cosmotron at Brookhaven National Laboratory attained energies above 2 billion electron volts and new exploration into nuclear phenomena got under way with this machine. At the same time, the exciting discovery was made that through the application of a new principle, machines capable of producing greater energies could be built at relatively low cost. Plans were developing for an accelerator employing this new method to produce energies up to 100 billion electron volts.

Unclassified detail on the advances made in all phases of the program appears in Part I of the report. Part II presents the condensed annual financial report for the fiscal year 1952. Part III describes the system for assuring safety of the population and guarding against property damage in the conduct of continental atomic-weapons tests at the Nevada Proving Ground, and sums up the results of the nationwide radiation monitoring operation carried on in conjunction with the tests.

Mound Atomic Laboratory

MOUND Laboratory at Miamisburg, Ohio, is the Atomic Energy Commission's first completely permanent installation and is operated for the Commission by Monsanto Chemical Company.

Mound Laboratory carries out highly classified process, research, and development activity for the AEC. In this respect, Mound is somewhat different from the National Laboratories such as Brookhaven, Oak Ridge, and Argonne, where a good deal of unclassified research is performed. Work at Mound is more completely related to the research on production processes. There are still secrets within the 170 acres enclosed by a chain-link barbed-wire-topped outer fence, patrolled by

armed guards. Within the grounds, about one tenth of the area is further restricted by a second fence enclosing some of the buildings.

Although Mound was built in 1948, its history began with the early days of the Army's top secret Manhattan District Project. Work still being done at Mound actually began in 1943 at another location in Dayton, Ohio, 10 miles north of Miamisburg.

Work at Mound which can be disclosed includes such functions as: (1) Nuclear studies, (2) construction and maintenance of special equipment, (3) biological research, (4) health physics, and (5) waste disposal.

Although the nuclear studies performed at Mound still are considered classified, considerable work is performed in the field of nuclear physics and nuclear chemistry in addition to research with various radioactive elements and their isotopes.

In the course of basic studies on radiation effects, investigators at Mound have rediscovered an old method of producing an electric current directly from radioactivity. If use of this so-called radio-electric effect proves to be feasible the discovery may have many industrial and laboratory applications, such as measurement of corrosion rates, analysis of alloys, study of surface film growth, and determination of molecular weights of gases.

To accomplish much of this basic research it was necessary for the laboratory to construct many specialized instruments which never before existed. One of the important and intricate pieces of apparatus constructed at Mound is a quartz-fiber microbalance. Although the balancing unit itself weighs only 0.14 oz, the entire balance weighs 600 lb. The quartz-fiber from which the balance is made is so fine that it would take 20 fibers to equal the thickness of a human hair. This balance, which is set on concrete piers going all the way to bedrock without touching the building in which it is housed, is capable of weighing accurately to one-three-billionth of an ounce. This is equivalent to one ten-thousandth of the weight of a single grain of salt.

Another tool devised at Mound is a microcalorimeter used to measure small quantities of heat from radioactive materials. In the microcalorimeter all of the nuclear energy of decay is turned into heat and accurately measured even when the source of heat is as small as 0.0003 calorie an hour. Since an ordinary 100-watt light bulb produces 90,000 calories an hour, the Mound calorimeter can detect a three-hundred-millionth of the bulb's heat.

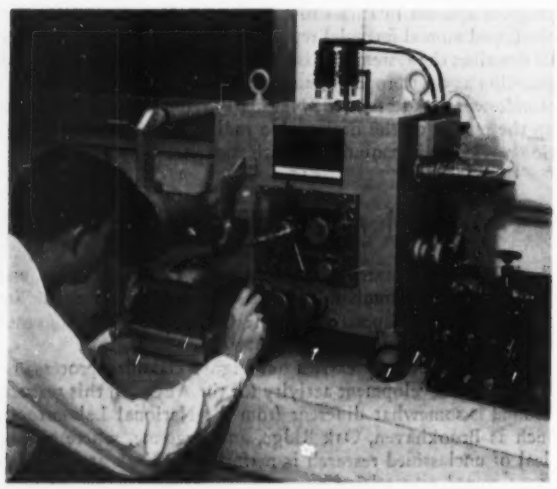


FIG. 1 QUARTZ-FIBER MICROBALANCE USED AT MOUND LABORATORY TO WEIGH SMALL AMOUNTS OF RADIOACTIVE MATERIALS

Another type of instrument used at Mound is the counter which records the number of disintegrations of a radioactive sample. Although the well-known Geiger counter is capable of detecting as many as 500,000 disintegrations a minute, technologists have readapted them to be capable of measuring as high as 220 billion disintegrations a minute. And other counters are capable of handling disintegration rates 100 times greater than this if necessary. This would mean disintegrations of more than 20 trillion a minute. Completely copper-lined counting rooms are provided to screen out the electrical interference and any radioactivity which might interfere with accurate counts.

Much of the work with the highly radioactive substances is handled in specially constructed "caves" where the scientists are protected from the dangerous rays by double glass walls filled with a concentrated chemical solution of high density. This glass and liquid wall is equal in stopping power to 6 to 8 in. of lead. Behind this wall special experiments are performed by remote control. A mechanical hand known as "Gertrude," which is electronically controlled by switches and buttons, enables the scientists to adjust equipment, pour liquids, and do other normal functions without exposing themselves to the deadly rays. By turning one switch, the mechanical hand turns one way; reversing the switch brings the hand back. Another switch controls lateral motion while still others raise, lower, open, and close the "fingers." The operator can even control the tension of the fingers from a 5-lb clutch to a 20-lb grip.

In this new field of atomic energy it frequently has been necessary for people to work with new, untested toxic or radioactive materials. The Atomic Energy Commission has been concerned about the effects of such materials on the people who work with them. Accordingly, biological research installations have been established at several places in this country and one of these is at Mound. The biological research division at Mound has carried out classified research on the effects of several radioactive materials on animals. Already several thousand rats and mice have been used and more thousands will be utilized each year. In addition to the direct study of the effect of injected radioactive materials on animals, a part of the biological research effort is an indirect study of the fundamental effects of radiation on single living cells.

The health physics work at Mound is extremely important. To protect employees who come in contact with highly radioactive material, an intensive monitoring program has been established and strict adherence to health physics rules is a "must." Areas exposed to radioactivity are constantly checked. Decontamination workers, following surveyors' directions, scrub and scrub to clean any hot area or equipment. Roving surveyors not only check laboratory facilities but also check the land outside the laboratory and even go off into the neighboring countryside to prove that radiation from the plant isn't going outside the plant. Protective clothing is supplied and laundering facilities are maintained at the laboratory to insure absolute cleanliness of all laboratory garments—not only from the standpoint of removing dirt, but more important, for making sure stray traces of radioactivity are eliminated. Periodic health examinations of all employees and constant housekeeping help to protect the laboratory worker.

Another safety feature is the air-conditioned and pressurized research building. This building was designed so that nonradioactive and lower-radioactive areas are under higher pressure than the other labs in the research building thus forcing any leakage air to flow toward the area of highest contamination.

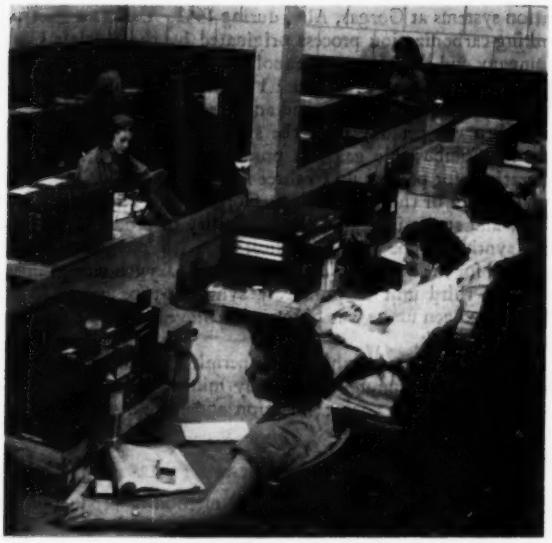


FIG. 2 MEASURING SAMPLES EMITTING ATOMIC DISINTEGRATIONS UP TO 220 BILLION A MINUTE AT MOUND LABORATORY

Another big item at Mound Laboratory is the problem of waste disposal. Long a major headache of the Atomic Energy Commission, a project for waste-disposal research has been turned over to Mound by the Commission. Radioactive waste cannot just be burned or flushed into sewers because radioactive air and water would result. At the present time this material is being stored at remote sites, but one day this "garbage-disposal" problem will become acute.

Elaborate procedures devised by Mound researchers have proved almost 100 per cent effective in handling radioactive waste. These methods are used not only at Mound but are extremely helpful in the operation of all AEC facilities throughout the country.

Fuel-Use Trends

THE extent to which Americans turned from coal to oil and gas heat between 1935 and 1951 is disclosed in a comparative fuel survey released by the Bureau of Mines, United States Department of the Interior. Solid fuels furnished more than 80 per cent of the heat used in 1935, but only 43 per cent in 1951, while the combined contribution of gas and oil rose from 19 per cent to almost 54 per cent.

The statistical survey, covering competitive fuels for space heating, is the first of its kind undertaken by the Bureau of Mines. It was prompted by numerous requests for data showing the changing fuel demand in recent years. It covers only fuel energy used for heating residential and commercial buildings—houses, apartments, hotels, offices, stores, and the like.

In 1935 all grades of fuel oil provided less than 10 per cent of the heat used in the types of buildings covered, but oil's share was over 25 per cent in 1951, according to the report. Quantitatively, oil consumption jumped from 98 million to more than 428 million bbl a year. At the same time, the number of oil burners used in households increased to more than 5.7 million, compared with slightly more than 1 million in 1935. However, due to such factors as smaller dwellings and more efficient burners, today's home burner averages less than 46 bbl a year against 50 in 1935.

The increased use of gas for heating closely parallels that of liquid fuels, according to the survey. All gases—natural, manufactured, and liquefied petroleum, the last-named popularly known as bottled gas—provided about 9 per cent of the nation's heat in 1935, but more than 25 per cent in 1951. After a slow but steady increase, the big jump in gas usage followed the installation of long-distance pipe lines after World War II. Oil usage followed a similar pattern, except for a decline during the war when coal reversed its steady decline as a heating fuel largely as a result of the rationing of oil and restrictions on the installation of oil-burning equipment.

Quantitatively, consumption of coal and other solid fuels for space heating remained virtually constant during the period studied, while that of oil and gas rose sharply, especially in the past few years.

On a smaller scale, the survey discloses that the use of electricity for space heating tripled during the 16 years, its contribution rising from under 1 per cent to 3.3 per cent of all fuel energy used for that purpose.

The report includes 13 tables of statistics comparing consumption of different fuels for heating. All calculations were based on the physical state of the fuel at the point of combustion.

A free copy of Information Circular 7657, "Fuels Consumed for Residential and Commercial Space Heating, 1935-51," can be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes St., Pittsburgh, Pa.

Synthetic-Fuels Technology

IMPORTANT technical advances in producing synthetic-liquid fuels from coal and oil shale, further recommendation that prototype commercial plants be started, and industry's rapidly growing interest in the program characterized the eighth full year of Bureau of Mines activity under the Synthetic Liquid Fuels Act of 1944, according to a Department of Interior report covering calendar year 1952.

High lights of progress described in the report include the following: (1) Advances in oil-shale technology, featuring the completion of a 200-ton a day oil-shale retort incorporating the Bureau-developed gas-combustion process; (2) successful operation of a pilot plant for retorting oil-shale fines continuously at high temperatures to produce high-test gasoline and chemicals; (3) experiments in gasification—an important step in producing oil from coal—whereby pulverized coal was gasified successfully with oxygen and steam at pressures up to 450 psi with greatly increased throughput; (4) advancing underground gasification of coal to the point where it was shown that gas suitable for producing synthetic fuels, pipe-line gas, or chemicals can be made; (5) progress in coal hydrogenation, the Bureau developing the first American vapor-phase catalyst and producing liquid fuels on a demonstration scale from Pittsburgh seam coal and North Dakota lignite; and (6) gas-synthesis research, which produced a durable Fischer-Tropsch catalyst and an economical process for removing carbon dioxide from synthesis gas.

Noting that improvements undoubtedly will be made as the synthetic-liquid fuels program advances, the report states that this does not alter the fact that industry should be encouraged to begin design and construction of prototype plants. Such plants would (1) provide a basis for rapid expansion of shale-oil and coal processes; (2) aid in conserving natural petroleum and reduce our dependence on petroleum imports; and (3) produce commercial quantities of important chemical products at reasonable prices.

OIL FROM SHALE

At the Oil-Shale Demonstration Plant, Rifle, Colo., experi-

mental data on the Bureau's gas-combustion process was obtained in a 10-day retorting run. The run was made in a 6-ton a day pilot unit on shale of about the grade that would be used in a commercial plant. Pilot-plant retorting facilities at Rifle are being expanded by construction of a 50-ton a day unit which incorporates improvements over the small one such as mechanical shale-handling facilities and complete instrumentation. It will permit a wide range of operation and will be used to advance process development and to guide demonstration-scale tests. Plans were made to begin operating the new 200-ton a day gas-combustion retort early in 1953. The gas-combustion process, which dispenses with external heating and cooling equipment and reduces water consumption, is particularly important because the country's large oil-shale deposits are in a semiarid region.

The method of mining oil shale in the Bureau's production mine at Rifle was changed during 1952 from a 3-level to a 2-level system, reducing mining costs and providing shale of nearly the same richness from either level. The mine produced approximately 22,000 tons of shale during the year, and about 2800 tons of selectively mined shale was delivered to the pilot-plant stockpile for blending in special retorting runs.

Intensive studies conducted at rifle of conventional thermal-refining processes showed that by combining two thermal techniques the major portion of refining operations could be transferred from near the shale deposits to a pipe-line terminal near a large center of population. Studies of retorting oil shale under pressure indicate that this process has advantages for producing power in conjunction with oil-shale operations.

At the Bureau's Laramie, Wyo., station, successful operation of a new pilot plant in which oil-shale fines are retorted at high temperatures was an important event. Flexibility in temperature and time variation permits control over the quality and type of products obtained by the entrained-solids method. High yields of regular and premium-grade motor fuels, important aromatic chemicals, and chemical raw materials can be produced.

Other research at Laramie included intensive study of thermal and catalytic refining techniques, investigations to develop means of improving feed stocks for further processing and for producing Diesel fuels, and analysis of foreign and domestic oil shales.

COAL GASIFICATION

In making synthetic-liquid fuels, purified synthesis gas accounts for about 70 per cent of the cost of the end product in the gas-synthesis process, and compressed hydrogen accounts for about one third of the total cost of the product in the coal-hydrogenation process. Direct coal gasification yields raw materials for synthetic-liquid fuels for chemicals, or for pipe-line gas. It is a convenient source of gas for ammonia production, and of power for driving turbines and generators.

During 1952 the Bureau concentrated on pressure gasification as a means of reducing costs in the gas-synthesis and coal-hydrogenation processes. Thirty-two runs were made on the pressure gasifier at the Morgantown, W. Va., station. Over 1300 tons of coal per hr was fed into a reactor and gasified under pressures up to 450 psi. Reactor capacity at this pressure was about 800 lb of coal per cu ft compared with only 10 to 20 lb of coal at atmospheric pressure.

Other work at Morgantown during 1952 included 34 runs on the atmospheric-pressure gasifier, tests on preheating of the coal feed stream, and installation of a new oxygen-producing plant.

UNDERGROUND GASIFICATION

The Bureau of Mines, co-operating with the Alabama Power Company, installed and operated three unit underground-gasification systems at Gorgas, Ala., during 1952. Using an electro-linking-carbonization process originated by the Sinclair Coal Company and the Missouri School of Mines to open the initial passage, the Bureau produced 1.1 million cu ft of 83-Btu gas per day from the first unit, and an average of 2.2 million cu ft of 95-Btu gas per day from the second and third units combined. Combustible gas was produced steadily during these operations for periods up to three months.

Operation of the third unit at Gorgas with alternate blasts of air and steam indicated the possibility of producing a 300-Btu synthesis-type gas. Gasification with oxygen was attempted for the first time late in the year. Oxygen was pumped into the third unit to produce a synthesis-type gas and, although oxygen usage was high, it is believed it can be reduced in further work.

These experiments, which may permit the economic use of coal beds that cannot be profitably mined, are an important approach to direct coal gasification and have attracted international interest.

GAS SYNTHESIS

With the indirect or gas-synthesis method of producing oil from coal, the coal is gasified with oxygen and steam. The purified synthesis gas, consisting of carbon monoxide and hydrogen, is passed over a catalyst and converted into liquid fuels. The process yields gasoline, jet fuel, Diesel oil, and heavier oils.

During 1952 technologists at the Bureau's Bruceton, Pa., laboratory devised a new technique for activating steel shot and iron turnings which produced a sturdy, long-lived Fischer-Tropsch catalyst. One of these catalysts was used for six months. Pilot-plant tests at Bruceton indicated that scrubbing impure synthesis gas under pressure with hot, concentrated potassium carbonate is more economical than conventional methods for removing carbon dioxide. Experiments made with nitrided iron catalysts showed that this modified gas-synthesis process yields large quantities of higher alcohols.

The Bureau's Gas-Synthesis Demonstration Plant at Louisiana, Mo., made four exploratory runs during 1952. During one run 85 per cent conversion of the gas was achieved without undue catalyst deterioration.

Engineering and economic studies for commercial-scale operations continued at Louisiana during the year, and the process design of a 10,000-bbl a day gas-synthesis plant for western Kentucky coal was completed and accepted by the National Petroleum Council.

COAL HYDROGENATION

Coal hydrogenation is a two-phase process. In the liquid phase, pulverized coal mixed with oil from the process is reacted directly with hydrogen in the presence of a suitable catalyst and under pressure. The product obtained—a heavy oil—is run through a vapor phase in which it is "converted" to gasoline and other products.

In 1952 the Bureau's hydrogenation demonstration plant at Louisiana, Mo., completed two extended liquid-phase operations and one vapor-phase run. The heavy oil obtained from northern Wyoming and Illinois coals in liquid-phase runs was converted in the vapor phase to 435,000 gal of 76 to 77-octane (motor method) gasoline and 27,000 gal of oil. Also, 2250 tons of Pittsburgh seam coal was processed in a liquid-phase run to yield 240,000 gal of vapor-phase charging stock, and 116,000 gal of solids-free heavy oil. Late in the year, hydrogenation of 3000 tons of North Dakota lignite was begun. As the runs progressed, adjustments and changes were made to improve the plant's performance.

At Bruceton, Pa., work began during the year on a new

single-phase hydrogenation process. Virtually complete hydrogenation of bituminous coal was achieved with a short reaction time in batch laboratory tests, and continuous plant tests are under way.

Besides the developments described in detail in the report, several processes are mentioned which, though in an early stage of development, may have far-reaching results. An outstanding example is the principle of the fluidized coal feeder developed by the Bureau of Mines. Preliminary studies indicate that this principle may lead to a practical system for transporting coal long distances in pipe lines.

According to the report, many synthetic-liquid-fuels program developments are being applied to other fields. For instance, pulverized-coal gasification is being used to produce synthetic ammonia. The first commercial plant, using the same type of pulverized-coal gasifier that was first installed in the Bureau of Mines, Louisiana, Mo., plant, began operating in Finland during 1952. American industry is also studying the use of pulverized-coal gasification to produce ammonia and other chemicals.

Asbestoprene

A SOFT asbestos-neoprene gasket material for light sealing pressures and medium high temperature has been developed from asbestos and the Du Pont Company's synthetic rubber, neoprene. Called asbestoprene, the material is made by Victor Manufacturing and Gasket Company, Chicago, Ill., and is unusual in that it combines compressibility with heat resistance.

Victor engineers say that, because of these two properties, the new material fills a gap in their line of gasketing materials between compressed asbestos sheet and cork or rubber. Compressed asbestos sheet has excellent heat resistance, but it is quite hard and requires high sealing pressure. Cork and rubber are soft and readily compressible, but are not suitable for service involving elevated temperatures.

Heretofore, when design engineers have required a compromise between compressibility and heat resistance, Victor and other gasket manufacturers have customarily offered glue-glycerin treated paper. Asbestoprene is a candidate for the same kind of application but it is said to be a better compromise. It is claimed to be more compressible and more heat-resistant than glue-glycerin treated paper—and in addition, has much better dimensional stability, does not cause corrosion of light metals, and is resistant to oils, water, gasoline, and antifreeze solutions.

It has been highly successful in automotive applications, for example, as the valve-cover gasket on tractor engines. This gasket is exposed to heat from the engine and manifold, and design of the valve cover is such that only light bolting pressure can be applied to the gasket.

Asbestoprene is made on modified papermaking machines where the neoprene can be added in latex form to asbestos pulp. This method of combining the two materials was made possible by du Pont's recent development of a special neoprene latex suitable for addition to paper pulp to make wet-strength paper. Victor found the new latex could be used with asbestos substituted for paper pulp. Advantage of the pulp-addition technique is the thoroughness with which the neoprene is dispersed on the asbestos fibers. The better the binder's dispersion, the greater its effectiveness.

Physical properties of asbestoprene are as follows: Tensile strength, 1500 psi minimum in the machine direction, 500 psi minimum in the cross-machine direction; Mullen burst strength 130 lb per $^1/_{16}$-in gage; compressibility, 20 to 30 per cent at a loading of 1000 psi; recovery, 40 per cent minimum; hardness, 70± 10 Shore Durometer A; flexibility, a $^1/_{16}$-in. sheet can be bent around a $^1/_{32}$-in. mandrel without cracking; oil resistance, 90 per cent minimum retention of tensile strength and 5 per cent maximum thickness change, after 5 hr immersion at 300 F in ASTM No. 1 test oil; gasoline resistance, 0 to + 5 per cent thickness change after 5 hr immersion at 70 F in ASTM No. 1 reference fuel.

Flexible Silicone Rubber

AFTER two years of development and highly satisfactory field testing by materials engineers in key aircraft companies, a new silicone rubber that remains flexible at —120 F and can be produced with uniform high quality has been announced by the General Electric Company, Waterford, N. Y.

This medium-durometer rubber, SE-550, will have wide application for gaskets and seals on fuselage equipment of high-flying aircraft as well as for wire insulation on ignition systems of arctic ground equipment, the announcement said.

Believed to have the lowest change in bending modulus of any commercially available elastomer, the new silicone rubber shows less than 25 points durometer increase from 500 F down to —120 F. The brittle point is actually well below —120 F. It is said to outperform all other silicone rubbers at any low temperature while still retaining the heat resistance up to 500 F of most other silicones.

G. E. states that the new compound is easily worked by rubber fabricators. It is removed from the container with no difficulty, mills and extrudes easily, and has good tear strength that permits stripping from hot molds.

As a base stock, SE-550 can be used by fabricators to produce different compounds with higher durometer and/or lower compression set. It can be colored with a wide range of heat-stable pigments.

SE-550 is readily available in compound form as a result of the completion in January of a $5 million expansion of manufacturing facilities at the G. E. silicone plant in Waterford where newly developed quality-control techniques and equipment provide reliable uniformity of every batch.

General Electric is planning to market gum for producing this compound to rubber fabricators later this year.

Electromechanical Comparator

A COMPARATOR has been developed by P. R. Weber, Mem. ASME, E. I. du Pont de Nemours & Company, Wilmington, Del., for measuring small bores to an accuracy within ±15 millionths of an inch. The work was carried out while Mr. Weber was associated with the Technical Section of du Pont's Polychemicals Department, Belle Works. According to Mr. Weber, the comparator has actually been used to measure a 0.175-in. bore which had to be machined within ±50 millionths of an inch uniformity over its $3^1/_2$-in. length. The important considerations in its design were low cost, speed of fabrication, calibration with standard gage blocks, and elimination of human touch.

The sensing element of this comparator is provided with two contact points, one of which is attached rigidly to a round slotted spindle and the other to a sliding member which fits into the slot. Mating tapered faces between the spindle and sliding member transmit a radial change in dimension between the contact points to an axial movement of the sliding member. The axial movement is measured by a Pratt & Whitney electrolimit gage which through an optical system throws the illuminated image of a pointer on the graduated screen of the indicator. The sensing element for the 0.175-in. bore covers a range of 0.010 in.

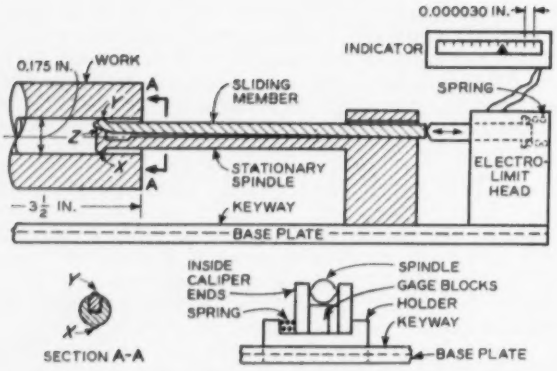


FIG. 3 ELECTROMECHANICAL COMPARATOR FOR MEASURING SMALL BORES

The entire comparator, except the indicator, is assembled on a steel base plate. The stationary spindle is secured in a steel block mounted to the base plate. The electrolimit head is also mounted on the base plate such that its pickup element touches the end of the sliding element. Fig. 3 shows diagrammatically the arrangement of the parts. Point *X* is attached to the stationary spindle and point *Y* to the sliding member. The mating tapered faces are at *Z*.

Two gage-block assemblies, varying in size by 0.001 in., are made up to calibrate the comparator for a given intermediate size of bore. Each gage-block assembly with its inside caliper ends is held in turn in a milled block which is aligned axially by sliding in a keyway in the base plate. With this arrangement, the gage blocks are kept square with the instrument axis.

Measurement of the bore is accomplished by supporting the workpiece accurately centered with the stationary spindle. An off-center error of 0.001 in. will result in a diameter error of only 12 millionths of an inch. The support member is a "V" block keyed to an axial groove in the base plate. The workpiece can therefore be slid axially over the spindle and readings can be taken along the bore length.

For future use on the other bore sizes, it will be necessary only to change the spindle and sliding member, according to Mr. Weber. It should be possible to measure bores even smaller than 0.175 in. and considerably larger and longer. The principle of this comparator should have broad use and such modifications, for example, as (1) the substitution of a mechanical pickup device in place of the electrolimit pickup where less accuracy is required and (2) providing adjustable points at *X* and *Y* to accommodate different-size bores with one spindle assembly, are possible.

Materials Testing

HIGH-temperature creep characteristics of nickel alloys, one of the most important measures of the performance of materials for jet engines, gas turbines, high-temperature steam turbines, and for meeting ASME Boiler Code Specifications, are being determined continuously in a large-scale test program in the laboratory of International Nickel Company, Huntington, W. Va., according to Baldwin-Lima-Hamilton Corporation of Philadelphia, Pa.

This phase of the materials-testing program is being conducted by means of more than 40 creep machines which apply loads ranging from 2800 to 100,000 psi at temperatures of 700 to 1800 F. Stresses and temperatures are held constant by automatic controls. Time for these tests varies from 100 hr or less up to 3 years or more. The longest test has been running three years at 2800 psi and at 1000 F.

One of the most common tests is the acceptance test for high-strength alloys to be used at high temperature. These tests are usually of short duration and are intended as an assurance that the material meets specifications. Materials that meet the ASME Boiler Code specifications must usually have a life of at least 20 years and creep tests at lower temperatures and stresses are therefore correspondingly longer.

In the development of new materials to withstand still higher temperatures and stresses, creep performance is determined by a series of tests at different temperatures and stresses, and are plotted in a family of stress-rupture curves. In many instances preliminary tests show whether a full series is justifiable.

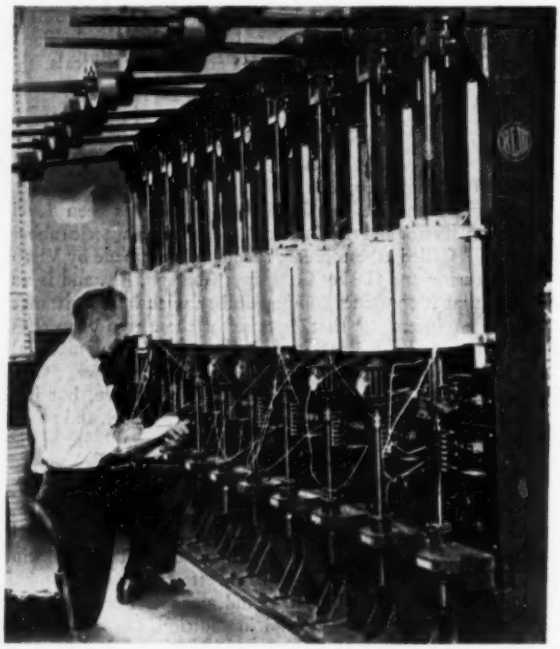


FIG. 4 HIGH-TEMPERATURE CREEP CHARACTERISTICS OF ALLOYS PRODUCED FOR USE UNDER HIGH STRESSES AND TEMPERATURES ARE DETERMINED BY MEANS OF THESE CREEP MACHINES

Newest creep machines used by Inco for these tests are 34 Baldwin lever-type machines of 12,000 lb capacity and one Baldwin screw-type machine. Ten lever-type machines have been modified by counterweights to balance the weight of the lever system. With this change the load on the test specimen is only the added weights suspended from the lever. This is particularly advantageous when using small-diameter specimens or sheet-metal specimens instead of the standard 0.505-in-diam specimen.

Another added accessory is shock-absorbing dashpots under the loading weights of several machines. Dial-type extensometers are also used in some tests in place of the more accurate instrument supplied with the machine. Electric-furnace temperatures for all creep tests are closely controlled by means of three thermocouples in each furnace. Furnaces have three separate heat zones under separate automatic control.

With the screw type creep machine, elongation versus time curves are drawn automatically on a chart at the top of the machine. The chart panel is driven vertically as the specimen

elongates and the recorder pen is driven horizontally by a clock mechanism. Load is applied by an electric motor-driven screw and is maintained constant by means of an electric contact with a deflected spring-supporting block. This machine is used for short-time tests.

Materials tested include the company's more than 50 standard alloys, all new developments in alloys with various heat-treatments, and any modifications of standard alloys for which there are indications of improvements in physical properties. In order to obtain specimens with properties identical with those of turbine blades they are often cut out of the blades after fabrication.

Fatigue Testing

THE Mechanical Testing Section of the Watertown Arsenal Ferrous Metallurgical Laboratory, Watertown, Mass., has been using a General Motors Research fatigue-testing machine as part of Ordnance development tests. Primarily a tension and compression-loading device, the machine has a capacity of 100,000 lb in each direction. Torsional loads up to 5000 in-lb can also be applied and phased in at any part of the tension or compression load. The cycling rate of this machine is from 400 to 3000 cpm. A tension load of 100,000 lb, therefore, can be applied to a steel specimen, the load removed, then reloaded in compression to 100,000 lb and unloaded. This cycle can be repeated up to 3000 times per minute. Methods of measuring, programming, and controlling the dynamic performance of the machine are manual except for the use of stroke-limit contacts and cycle counter.

A need arose for automatic-control equipment that would enable fatigue tests to be conducted at values of constant axial force or constant axial deflection and/or constant torsional force or constant torsional deflection during the entire specimen life and over the full-load range of the machine. Under the technical supervision of the Laboratory at Watertown Arsenal, this electronic equipment was designed and developed by Lessells and Associates, Inc., of Boston, Mass. In general, the function of the electronic control circuits is to collect electrical information on how the fatigue machine is performing (through sensing elements) and what the machine is supposed to be doing (by preset signal) and then to instruct the control motors when and how to operate to make the machine apply the loads or deflections requested.

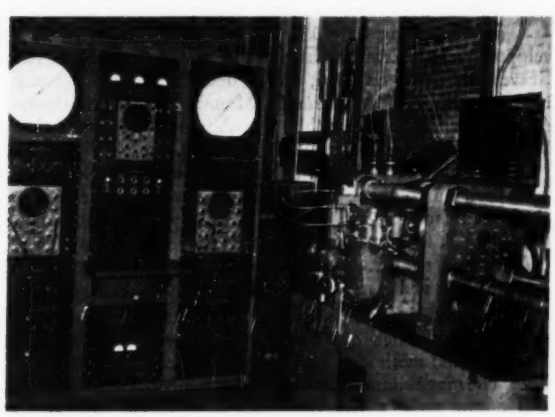


FIG. 5 WATERTOWN ARSENAL-GENERAL MOTORS RESEARCH FATIGUE-TESTING MACHINE
(At left is the electronic automatic-control equipment for the fatigue-testing machine at right.)

The electronic control panel has two Bourden tubes—one shows axial force and the other torsional forces. Two dual-beam Dumont cathode-ray oscilloscopes are used to set and control axial loads or deflections and to set and control torsional loads and deflections. A Polaroid land camera can be attached to the screen of the oscilloscopes and photographs taken of the torsional and axial load or deflection patterns.

A single-beam Dumont cathode-ray oscilloscope can be used to jack in any one of the axial or torsional load or deflection and bending patterns to spot-check a single pattern.

Both sides of this oscilloscope have provisions for the insertion of jacks to obtain Brush recorder permanent records of load, deflection, and bending. A tachometer has been installed on the G.M. machine and is attached to the top center of the electronic panel and operates a voltmeter which accurately measures the cycling rate.

This equipment will now produce accurate cyclic loads purely sinusoidal in character. Few moving parts in any machine or device are subjected to such loads and therefore the correlation of laboratory data with service failures has inherent errors and unknown limitations.

For instance, the firing of a gun produces a complex stress wave in its companion parts. Under repeated action, this form of load-time function often produces failure in service, and these failures do not lend themselves to systematic engineering analysis. There is an increasing need for test equipment that is capable of reproducing actual force-time and deflection-time functions imposed during service.

The anticipated second phase of this project is to design, develop, and construct a hydromechanical wave-form simulator to be used with the Watertown Arsenal-General Motors research fatigue-testing machine and the recently installed electronic control panel. It is believed that the resulting test facility will be the first of its kind and make possible a better understanding of force, deflection, and time as they relate to the phenomenon of fatigue.

Defense Research

MORE federal support for basic scientific research in the universities to balance the effect of applied research and development work upon science teaching and fundamental research in educational institutions in the United States was urged by Dr. Alan T. Waterman, director of the National Science Foundation, before the Southwestern Conference of the Institute of Radio Engineers in San Antonio, Texas.

Pointing out that institutions of higher learning constitute the main source both of new scientific knowledge and of highly trained scientists, Dr. Waterman emphasized that universities dare not devote all their research and training resources to applied work and development. Since in these critical times the United States must continue defense research and development full blast, Dr. Waterman concluded that additional support for basic research is of the utmost importance to encourage the universities in the direction of resuming their traditional role in research and education.

If and when current defense needs are less pressing, Dr. Waterman proposed that university leaders and Federal officials study the possibility of channeling a larger part of the Government's practical research problems into industry or into the Government's own laboratories.

Established by the Congress in 1950, the National Science Foundation is charged principally with the functions of developing national policy in science and the support of research and education in the basic sciences. One of the first studies made by the Foundation indicates that Federal funds for applied re-

search and development in nonprofit institutions totaled $246,532,000 in 1952, while basic research support in such institutions totaled only $71,078,000. Of the total funds allocated for basic research, 48 per cent, or $34,237,000, was administered by the Department of Defense; 39 per cent, $27,848,000, was administered by the Atomic Energy Commission; and 7 and 2 per cent, respectively, by the Federal Security Agency and the Department of Agriculture. Thus 87 per cent of the Federal basic research program in nonprofit institutions was administered in fiscal year 1952 by the first two agencies named. Only 1½ per cent of the program, $1,075,000, was administered by the National Science Foundation.

Dr. Waterman stressed the urgency of current defense research but pointed out that the entire national economy was dependent upon the search for new knowledge on the frontiers of science. He proposed that funds for basic research be materially increased in order that universities and colleges might carry on their principal functions of teaching and research without the necessity of taking on research contracts which were inappropriate to their facilities. He also called attention to the fact that current enrollments in the schools and colleges indicate that less than half the number of scientists and engineers who were graduated in 1950 will be graduated with bachelors' degrees in 1954. In the face of the steadily mounting demand for scientists and engineers, every effort must be made to insure a continuing supply of young people trained in these fields.

The Foundation is devoting approximately half of its available operating funds to the support of graduate fellowships in the sciences. It is emphasizing first-year fellowships in order to increase the number of students entering graduate school. The Foundation is also studying ways and means for improving the quality of science teaching and for attracting capable students with genuine aptitude for science and technology into those fields.

Future Jet Propulsion

SPEEDS of jet planes approaching 20,000 mph—more than 15 times the speed of the rotation of the earth—are possible within the foreseeable future, Prof. Frederick K. Teichmann, Mem. ASME, head of New York University's Guggenheim School of Aeronautics, declared recently in an address on "The Future of Jet Propulsion," at The Cooper Union, New York, N. Y.

He based his prediction on the expectation that jet engines of 500,000 lb thrust and equal to 125 times the power of today's aircraft piston engines will be developed in the near future.

Excerpts from Professor Teichmann's address follow:

"Speeds have become so great that the human mind can no longer react with enough speed to make the decisions required in a split second. There is therefore a need for automatic controls and operation. These are forthcoming.

"Guidance systems, containing electronic devices are capable of 'thinking' at a rate 10,000 times the speed of the human brain.

"With a human cargo in such high-speed airplanes, there must be pressurization, refrigeration, as well as a careful study of all human needs during extended flights at high altitudes.

"Developments are presently under way in new types of protective clothing that should take care of temperature, acceleration, and pressure problems.

"In the fully automatic airplane of the future we may use no humans at all. Fully automatic airplanes may soon fly our mail and transport cargo across the continent and the world.

"The advantages of carrying freight by air are enormous. To mention only a few: (1) Materials may be ordered closer to actual selling seasons, (2) storage warehousing may be eliminated, (3) inventory control reduced, (4) product delivery dates met more easily, (5) plant shutdowns avoided, (6) material shortages controlled, (7) minimum crating requirements necessary, and (8) less damage likely in transit.

"We need more research on fuels, on high-temperature-resistant metals and ceramics, on methods of cooling the inner walls of rocket engines, and the outer skins of high-speed air-frames.

"The compressor and other parts at the inlet end of the engine usually contain a large amount of aluminum and magnesium alloys. These materials, while satisfactory, have rapidly decreasing strength as the temperature increases above 400 F.

"The development and production of titanium and its alloys is being watched with the greatest of interest.

"Titanium has the following three qualities that grip the attention of jet men: (1) It weighs but two thirds as much as ferritic materials and is equally strong, (2) it retains its strength up to about 800 F which is far above the limiting temperatures of aluminum and its alloys, and (3) it is almost completely unaffected by salt air and water.

"The toughest technical problem on the immediate supersonic schedule is not the sonic barrier but the 'thermal barrier.'

"The fact that the resistance to flight increases very rapidly as the speed approaches that of sound has been well publicized. The ratio of the speed at which the air-borne vehicle travels to the velocity of sound at that temperature has been given the name Mach number in honor of the Austrian physicist, Dr. Mach, who first explained the dependence of certain phenomena on the speed of sound. The so-called sonic barrier is the point at which the speed of the air-borne vehicle reaches that of sound.

"Air friction at speeds of 1300 mph at 40,000 ft produce temperatures of more than 200 F on the airplanes' inner and outer surfaces—well above the boiling point of water at that altitude.

"Either new temperature-resistance metals or more effective methods of cooling will be necessary.

"Here again titanium alloys, also certain types of sandwich construction offer great possibilities.

"All of these problems are only mild determents to the scientist and to the engineer. Solutions will be found."

Magnesium Auto Body

A DIFFERENT type of auto body—made of magnesium and weighing only 132 lb—has been designed and developed by R. J. Cross, managing director of Essex Aero, Ltd., Gravesend, Kent, England, and is described in the February, 1953, magazine of *Magnesium*. Mounted on a British-made Allard chassis, the automobile was shown at the International Magnesium Exposition in Washington, D. C. See Figs. 6 to 9.

Called the S-X Mag-body, Mr. Cross says his company is in a position to make all-magnesium custom bodies for any U. S. manufacturer, and that he is already conducting experimental work for some of them.

According to Mr. Cross, the result of 15 months' experimental work and tests has proved the following:

1 A magnesium car body is practical and lighter than any similar body which can be constructed of plastic, using the materials and methods known to plastic technicians today.

2 The magnesium body can be cost-competitive with plastic, and might prove cheaper. Magnesium would involve only minor changes in the auto industry's craft practices; whereas plastic molding with its necessary thermosetting would involve radical changes in personnel and equipment.

3 Existing body-repair facilities could handle magnesium

bodies much as they now do steel bodies. Repairing plastic bodies presents many difficulties.

4 Magnesium promises the likelihood of ultimately discarding the orthodox chassis and incorporating it with the body itself.

Conceiving the body as a one-piece structure was accomplished by building it in sections, then welding the sections into one rigid unit. Heavier gages of magnesium sheet were used at places of high stress.

Reinforcement of side windows and door openings, Mr. Cross says, was accomplished by using folded sections and shapes fabricated from magnesium sheets by argon-arc welding.

Doors are all-welded structures of extreme rigidity and lightness, and are swung on self-aligning ball races. Door catches are operated by push buttons, both inside and out.

Also fixed to the body is the radiator grille, welded two feet forward of the radiator, the intervening gap being completed with a duct, the sides and top of which are fixed to the body, while the floor is formed by an apron on the chassis.

Automatic Controls

INCREASED use by industry of more and more instrumentation and automatic control equipment to help meet expanded production goals in face of a tight labor supply was one of the significant industrial trends during 1952. This continued investment in industrial instrumentation in 1952 showed a 10 per cent rise over 1951 and represented many new applications for both new and old instruments. Indications are that the trend toward wider use of instruments and controls will continue and will be a great stimulant to greater volumes of business for the instrument industry, according to Henry F. Dever, president of the Brown Instruments Division, Minneapolis-Honeywell Regulator Company.

Reporting on the growth of automatic operation in industry, Mr. Dever pointed out that rates of expenditures for measuring and control instruments alone have increased twice as fast (in the last 15 years) as capital expenditures as a whole. Measuring and control instruments, he explained, provide the best index available for determining how far automation has gone.

Sales of instruments for industrial recording and controlling, he pointed out, will, by 1955, have doubled purchases of 1950. This follows a pattern of increasing volume which indicates that since 1930 annual sales of these instruments have multiplied by some 10 times, he said. Of the capital expenditures for new plants and equipment invested by industry, industrial instrumentation's share has risen from 0.2 per cent in 1930 to 1.2 per cent during recent years.

Studying the pattern of industrial purchasing further, Mr. Dever explained that of the nation's 250,000 manufacturing firms, some 65,000 buy 80 per cent of the industrial instruments produced. Of this total, 25,000 represent new customers since the start of the Korean incident. This leaves at least 185,000 firms as potential instrument customers, he said.

Citing the process industries—historically the most prolific users of instrumentation—Mr. Dever reported that capital expenditures during 1952 totaled about $13 billion. If all of these plants were automatized, he said, over $700 million would have been spent for measuring and controlling instruments. The fact is that the 1952 production of these instruments will slightly exceed only 10 per cent of this potential.

According to Mr. Dever, the chemical industry, long a leader in aggressive use of industrial technology and instrumentation, faces the prospect of doubling production of nearly a dozen major chemicals to meet Defense Production Administration targets. In addition, there is the work being done in

FIG. 6 A HUSKY MAN CAN LIFT MAGNESIUM AUTO BODY ALOFT

FIG. 7 MOUNTED AT ONLY SIX POINTS, MAGNESIUM BODY IS EASILY REMOVABLE

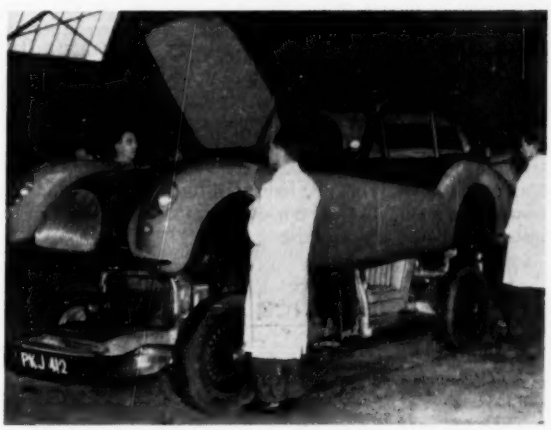


FIG. 8 LOWERING MAG-BODY ONTO ALLARD CHASSIS

FIG. 9 COMPLETED ALL-MAGNESIUM-BODY EXPERIMENTAL AUTO

fluorocarbons, mining, and metallurgical chemicals while utilization of high temperatures and pressures should stimulate the search for new lubricants, alloys, and refractories which will withstand rigorous operating conditions. Increased use of automatic controls will help meet this formidable challenge, Mr. Dever said.

He also saw the increasing diversity of petroleum products raising new technical problems that the instrument industry and the petroleum manufacturer must solve together. Petrochemistry, already deeply involved in the production of plastics, synthetic fibers, detergents, and insecticides, will need the support of the instrument industry to continue its advances. Processes for obtaining synthetic fuels from natural gas, oil shale, and coal—now in the development stage—will of necessity require the precise measuring and controlling instruments made by the instrument industry.

There is also the market for instrumentation represented by the obsolescent plant, Mr. Dever noted. Because of the war and postwar defense effort, hundreds of new plants in almost every segment of industry include the most modern technological advances, thus making for efficient operation and low costs. In comparison, thousands of older plants are daily approaching technological obsolescence and in future periods of intense competition, which, he said, we feel are not far off, will have to modernize or die. Instruments provide an important phase of such modernization and we look for important sales in those plants, he stated.

Mr. Dever also saw the increased tempo of scientific investigation in both the Federal government and private industry—estimated at $1500 million annually in each—as having a powerful impetus on the future sales of the instrument industry.

Automatic recording and measuring instruments are tremendously important to the physicist, the biologist, the chemist, and the mathematician in gathering and correlating the tremendous amount of technical data uncovered daily, Mr. Dever said. He also pointed out that such research projects as those concerned with nylon, penicillin, cortisone, rayon, atomic energy, or the antibiotics, must be carried through under carefully controlled conditions.

These few examples, Mr. Dever concluded, illustrate that it is not by coincidence that the industrial-instrument demand continues heavy and that the outlook from the viewpoint of the instrument maker is optimistic.

Streamlined Drafting

A PROGRAM designed to streamline industrial drafting is being employed by the General Electric Company, Schenectady, N. Y.

The more than 5000 draftsmen employed by the company are being encouraged to strip the frills from their drawings, and, according to Harry A. Winne, Hon. Mem. ASME, vice-president of engineering, the company thereby saves from 20 to 50 per cent of the time normally required to prepare drawings.

Savings in other related operations are expected as a result of the switch from methods said to be outmoded.

It is also anticipated that the need for additional manpower will be reduced and more time will be available for the most important part of any industrial draftsman's job—the real productive effort of creative thinking.

In addition to the saving in manpower, there is a definite saving in the amount of materials and facilities. In one instance, a drawing which required 57 sq ft of drafting paper was replaced by one with less than 4 sq ft without losing clarity or accuracy.

General Electric drafting departments use more than 75 million sq ft of drafting paper a year. Under the simplified plan it is indicated that more than $60,000 a year may be saved in the cost of paper.

FIG. 10 STREAMLINED DRAFTING PROGRAM RESULTS IN FEWER LINES AND SAVES TIME

(Both of these drawings tell the same story but General Electric Company draftsmen are being encouraged to use the smaller, simpler one at the left. The larger drawing required 57 sq ft of drafting paper, and eight days of a man's time to draw it. The smaller drawing took two days and required less than 4 sq ft of paper.)

The drawing which was 57 sq ft in size required eight days of one man's time while the less than 4 sq ft of drawing required only two days for one man, a saving of 75 per cent in that case.

Although modern industrial drafting embraces many economical practices, three of the easiest and yet most effective which can be applied immediately to reduce the time and effort to make drawings are being encouraged, the company said.

Simplification of delineating, elimination of nonessentials, and extensive use of free-hand drawing are being encouraged. In the most simple terms, simplification of delineation and elimination of nonessentials means merely eliminating those things which add nothing to their accuracy, completeness, or clarity.

Extra views, unnecessary elaboration, superfluous lines, repetition, and conventional representation instead of symbolism are but a few examples of work that never should have been done. The direct way, the simple way, are encouraged as the best way.

However, the draftsmen are being cautioned that the use of short cuts or abbreviated methods does not relieve them of their obligation to draw clearly, legibly, and in a manner easily understood. Simplified drawing is not a license for careless, sloppy, or indifferent work.

The company's draftsmen are being urged, whenever possible, to use free-hand drawing beyond its present narrow limits.

Tests have proved that free-hand drawing, when used judiciously, is both practical and economical. With all factors

made equal, actual drawing time for the average draftsman is reduced between 20 and 30 per cent.

Hot-Spring Power Plant

A STEAM station for a tin mine in the heart of the Belgian Congo, which derives its power from a hot spring, is described in *The Overseas Engineer*, February, 1953. The plant, built by Belliss and Morcom, Ltd., Birmingham, England, successfully completed its trials recently.

According to the article, production of power in mountainous country, 100 miles from the nearest settlement, represented a major problem when the Société d'Exploitation et de Recherches Minières au Katanga developed plans for opening a tin mine at an altitude of 2500 ft in the Belgian Congo. However, a hot spring on the mine site offered a ready solution.

A normal hot-water supply of 31,750 gph at 196 F is available from the spring, and cold water can be drawn from a reservoir 200 yd distant, and at a level some 20 ft higher than the overflow. The quantity is dependent upon rainfall, but it has been estimated that 127,000 gph at 74.5 F will be available for the greater part of the year.

By lowering the level a few feet it would be possible to increase the hot-water supply to 55,000 gph and the temperature to 200 F. The plant has, therefore, been designed for "overload" operation under these conditions.

To maintain the flow of cold water in the dry season a large storage reservoir will be built at a lower level than that of the power station, the water being returned to the upper reservoir during the night—when a decrease in load provides surplus power which can be employed for this purpose. The respective areas of the upper and lower reservoirs are 24,500 sq ft and 73,000 sq ft.

Three pumps of different outputs will be installed, so that any combination may be used according to requirements. To provide for the possibility of a complete failure of the supply to the upper reservoir, a mechanical water cooler will probably be installed above the level of the plant. The pumps will then circulate water from the lower reservoir through the cooler and back to the same source.

The load for the 8-hr day shift will be about 200 kw; during the remaining 16 hr it will be reduced to an average of 150 kw.

The power unit comprises a Belliss and Morcom turbine, running at 4500 rpm, which drives a Lancashire Dynamo and Crypto alternator through David-Brown reduction gears at 1500 rpm. The normal continuous rating of the plant is 220 kw, which is obtained when the flow of water is 31,750 gph at 196 F. Approximately 12,000 lb of steam per hr is produced at $4^1/_2$ psia and $4^1/_4$ lb of steam is available for the turbine. The overload rating is 272 kw and the designed exhaust vacuum 28.64 in. at a barometric pressure of 30 in. in both cases.

No current from an external supply being available to operate the air vacuum pump for starting purposes, a pilot boiler set burning wood fuel, built by Belliss and Morcom, will be installed. This system obviates the costly transport of oil or coal, which would be required for other types of set. It has been decided to employ pumps operated by steam jet, in preference to water-jet units, so that the heat from the second stage can be reclaimed by using it to superheat the turbine steam, thus reducing consumption and the possibility of turbine-blade erosion.

Copper Recovery

RECOVERY of millions of dollars' worth of copper from waste piles at American copper mills is foreseen as the result of experiments at Michigan State College's Engineering Experiment Station, East Lansing, Mich. A newly developed coal-tar product which removes a copper-bearing mineral (copper silicate) from impurities is the key to the process.

As much as 90 per cent of the copper-bearing mineral contained in samples was recovered in the tests. In some cases only one pound of the new synthetic chemical was needed to recover 17 lb of copper as copper silicate.

Only the copper-bearing mineral is recovered in the process.

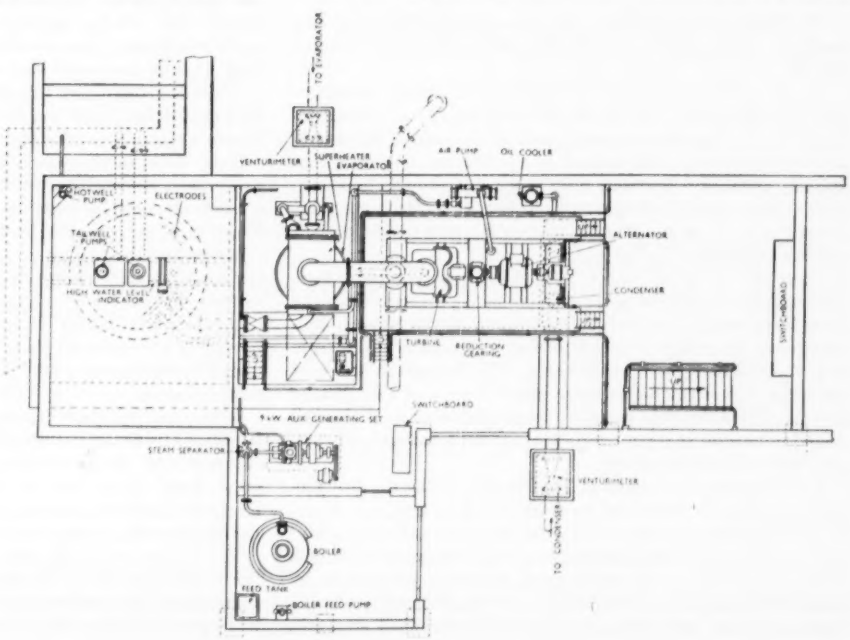


FIG. 11 PROPOSED LAYOUT OF HOT-SPRING POWER STATION SHOWING INSTALLATION DETAILS

(The turbine, reduction gearing, and alternator are all mounted on the large rectangular condenser. The normal rating of the set is 220 kw based on a water flow of 31,750 gph, at a temperature of 196 F, which produces 12,000 lb of steam per hr.)

Standard commercial processes must be used to produce the pure copper.

Although commercial chemical processes are being employed to recover copper from the waste dumps by acid treatment, it is estimated that substantially higher yields could result from the new process if the copper silicate were first separated and then acid-treated. Concentration of the copper silicate increased the efficiency of the acid treatment necessary to recover the copper.

In the Michigan experiments, mixtures of the samples are ground with flint pebbles and added separately into a large container. The mixture then is agitated with water, pine oil, and the new synthetic chemical. The copper-bearing mineral is contained in the soaplike foam which rises to the surface of the liquid. The foam is then skimmed from the surface and filtered to recover the mineral.

The foam contains as much as 90 per cent of the amount of the copper-bearing mineral that was in the original sample.

The new chemical was designed especially for the recovery of the mineral after studies of the atomic arrangement of the copper silicate. The chemical is synthetically made from readily available commercial materials.

Technically known as a "flotation" process, the method is similar to commercial processes employed in the recovery of minerals containing other metals.

A report on the flotation process was delivered by Prof. C. C. DeWitt, director of the experiment station, at a recent meeting of the American Institute of Mining and Metallurgical Engineers, at Los Angeles, Calif.

Copper Tensile Properties

THE National Bureau of Standards has recently completed a study of the effect of prior strain history on the room-temperature tensile properties and microstructure of high-purity copper. Tensile tests were made on oxygen-free high-conductivity (OFHC) copper initially as annealed, as cold-drawn different amounts, and as prestrained in creep at 110, 250, and 300 F.

The Bureau's results show that the strength, ductility, and hardness of the copper are markedly affected by its prior strain history.

Considerable interest has been stimulated among metallurgists by suggestions that the tensile properties of metals are dependent only upon the instantaneous strain state of the metal, and are practically independent of the manner in which this state is attained. Previous NBS work has shown, however, that as some metals and alloys are deformed, hardening and recovery occur in such a manner that subsequent tensile properties are materially affected.

Four bars of OFHC copper, 99.99 plus per cent pure, were procured for the NBS study. All had been processed from the same lot of copper, but each had been subjected to different conditions of annealing or cold drawing. Specimens taken from the various bars were subjected at the Bureau to different amounts of prestraining in creep under tension at 110, 250, or 300 F. The differently preconditioned specimens were then all tested in tension at room temperature at the same rate of extension of 1 per cent per minute.

Cold-drawing the copper at a relatively fast strain rate generally resulted in increased strength and hardness, but in decreased ductility (as measured by the extension and reduction of area at fracture). Prestraining at a high temperature or at a low strain rate, on the other hand, generally resulted in reduced strength and hardness as well as reduced ductility. Specimens with the large grain sizes showed lower yield strengths and hardness values; but grain size had very little effect on tensile strength, fracture strength, and ductility. Hardness values of the fractured tensile specimens, obtained at room temperature, confirmed the results of the tensile tests.

The microstructures of the tensile specimens were, in general, consistent with previous assumptions that cracks of a transcrystalline nature, and substructures, are nucleated during the second stage of creep, and that these phenomena are associated with prestraining at low temperatures and fast strain rates.

Cracks thus nucleated grew to microscopic dimensions during the tensile tests. Prestraining at elevated temperatures and slow strain rates tended to result in fractures of a less ductile type and in cracks of an intercrystalline nature.

Iron-Sulphide Ores

A PROMISING future is seen for Minnesota's iron-sulphide deposits in Aitkin and Carlton Counties, according to the Bureau of Mines of the Department of the Interior. These ores someday may not only provide the state with a new industry, sulphur, but also may prove the missing link in the development of Cuyuna Range manganese.

A recent report of the Bureau disclosed that laboratory tests on iron-sulphide ores from two deposits in the Minnesota counties averaged an 87 per cent recovery of sulphur. These concentrates would be a good source of sulphur and its related products.

The relatively low-silica content of the concentrate also indicated that a high-grade iron-oxide sinter suitable for blast-furnace use by the steel industry could be produced after recovery of the sulphur from the concentrates.

The flotation tests were conducted by Bureau metallurgists in laboratories in the Mines Experiment Building on the University of Minnesota campus, following an extensive drilling program during 1950-1951.

Perhaps even more important is the possible use of these iron-sulphide deposits in the development of a Minnesota manganese industry from Cuyuna Range manganiferous ores, it was pointed out. Using sulphur-dioxide gas, the Bureau is currently conducting pilot-plant tests in the recovery of manganese from Cuyuna carbonate slate ore in a sulphatizing furnace in the Mines Experiment Building. This will be followed by the final leaching step in a flotation mill to be installed in the Bureau's manganese pilot plant at Fort Snelling.

If the use of sulphur-dioxide gas in the process under investigation is as successful as laboratory tests have indicated, there is a definite tie-in between the eventual development of Cuyuna Range manganese-bearing iron ores in Crow Wing and Aitkin Counties and the nearby iron-sulphide deposits in Aitkin and Carlton Counties. Iron sulphide could be burned to produce sulphur-dioxide gas for use in the recovery of manganese. Link together North Dakota lignite as a potential source of fuel and power for a commercial plant, and three great natural resources from the two states could be the basis for a new industry, it was indicated.

Minnesota's Cuyuna Range has about 500 million tons of low-grade iron material containing from 10 to 25 million tons of manganese. Of the total manganese used by the steel industry, only about 10 per cent is furnished by domestic producers. Every ton of steel requires about 13 lb of manganese as a scavenger of impurities in steel manufacturing.

The Bureau investigations and mineral-dressing studies of Minnesota's iron-sulphide deposits were prompted by national demands for increased production of iron and sulphur and for the finding of new sources for these strategic materials.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

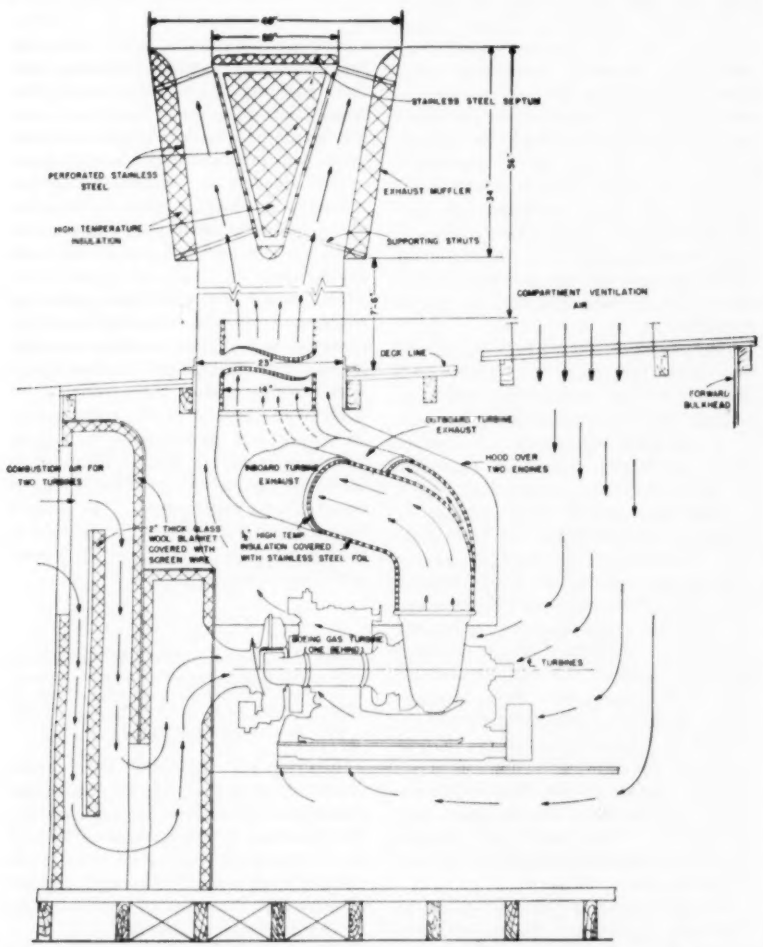
Gas Turbine Power

Installation Factors Related to Gas Turbines in Closed Compartments, by L. W. Shallenberg, J. O. White, and K. E. Schlachter, Jun. ASME, Engineering Experiment Station, Annapolis, Md. 1952 ASME Annual Meeting paper No. 52—A-130 (mimeographed).

THE U. S. Navy is presently constructing a group of wood-hulled vessels. To meet size and weight limitations, gas-turbine engines are being installed for generator drive.

Problems of design which arose in connection with the installation of gas-turbine engines in a closed compartment are discussed and the solutions as developed at the U. S. Naval Engineering Experiment Station are given.

The problems discussed in this paper are: (1) The maintaining of satisfactory temperature limits in the compartment, (2) the maintaining of satisfactory temperature limits on the exhaust ducting



SCHEMATIC DRAWING SHOWING COMBUSTION AND VENTILATION AIR-INLET SYSTEMS, COMBUSTION GAS AND VENTILATION AIR-EXHAUST SYSTEMS, AND EXHAUST MUFFLER

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and stack, (3) a combustion air-inlet system that will prevent sea-water droplets entering the compressor, partially silence the compressor noise, and give a low intake pressure loss, and (4) an exhaust muffler that will partially silence the turbine exhaust noise and give a low-exhaust system pressure loss.

The Closed-Cycle Gas-Turbine-Power Plant, by S. T. Robinson, Mem. ASME, American Turbine Corporation, New York, N. Y. 1952 ASME Annual Meeting paper No. **52—A-137** (mimeographed).

IN this paper a brief background of development of the closed-cycle gas-turbine-power plant is presented covering the experimental plant as originally built by Escher Wyss of Zurich, Switzerland, and subsequent work in the development of coal, oil, peat, and gas-burning plants as well as work that has been done in utilizing waste heat from process industries.

Characteristics of this type of plant are discussed, together with problems of design. Particular emphasis is paid to design improvements to be achieved through the use of compact heat-transfer surfaces and developments in air heaters.

According to this paper, the closed-cycle air turbine plant can find its best field of application in selected central station, industrial, and marine fields.

The power plant was originally conceived and designed for electric power generation where better efficiencies than previously existed with steam were demanded, and where the power limitations of the open-cycle plant precluded its use with a single-flow turbine to outputs of the order of 10,000 kw.

Plants for power generation run at constant speed and can therefore be single-shaft sets. Reduction gears will be required with plants of small outputs. A separate power turbine will be required with plants of medium output and large output plants can operate with the generator directly coupled to the machinery set.

In addition to power generation, waste heat from a closed-cycle gas-turbine plant is available in cooling water which can be released as steam or hot water. The amount of waste heat that is used in processing will not affect the power-generation efficiency, contrary to the case with an extraction steam turbine. Such a scheme is being developed by Escher Wyss for district heating in a Central European City.

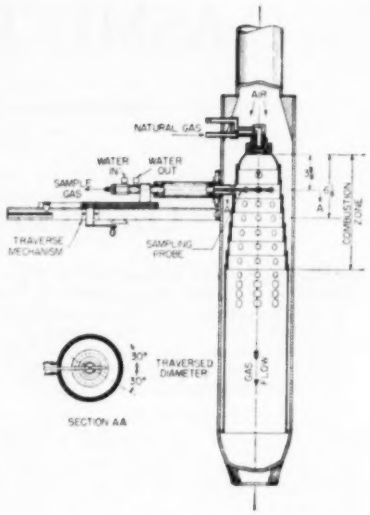
Often the fact is overlooked that the gas turbine is currently being developed in the lower power range because of its high efficiency compared with the steam plant, as the efficiency of the latter will drop considerably in sizes of less than 10,000 kw. The efficiency of a closed-cycle gas-turbine plant will drop less than three points from a 10,000-kw design to one of 2000 kw which makes the smaller-size plant extremely attractive for industrial use.

Temperature and Gas-Analysis Surveys in the Combustion Zone of a Gas-Fired Gas-Turbine Combustor, by K. L. Rieke, Westinghouse Research Laboratories, East Pittsburgh, Pa. 1952 ASME Annual Meeting paper No. **52—A-97** (mimeographed; to be published in Trans. ASME).

PROBLEMS encountered in the design of gas-turbine combustors are not essentially different from those associated with any other industrial combustion equipment except for the complications introduced by the extreme space limitations and the wide range of fuel-air ratios under which the former must function. In a satisfactory gas-turbine combustor, optimum conditions with respect to preparing the fuel, performing the mixing of fuel and oxidant, and piloting the combustion must be accomplished without the aid of adjustable dampers or other controls which function as operating conditions change. To expeditiously achieve such a design, detailed information as to the admission of the fuel and oxidant and their subsequent mixing and reacting is highly desirable.

This paper presents a report of explorations of the possibility of obtaining such information by temperature and gas-analysis surveys in the combustion zone of a gas-fired combustor. A radiant target pyrometer, developed especially for gas-temperature measurements, and a sonic-flow orifice probe similar in design to that proposed by Blackshear have been successfully used in making temperature explorations in the combustion zone of a gas-turbine combustor. A continuous gas-sampling procedure employing a Beckman Oxygen Analyzer was used to make the gas-analysis surveys in the combustor. From measurements of oxygen concentration in the sample at specified points in the analysis train, the per cent by volume of carbon dioxide, oxygen, carbon monoxide, saturated hydrocarbons, and nitrogen were determined. From such gas analyses the fuel-to-air ratio throughout the traversed region was calculated.

Data presented indicate that the maximum gas temperature in the combustor occurs where the fuel-air ratio is near stoichiometric. There are regions of unburned fuel and carbon monoxide with



COMBUSTOR TEST APPARATUS

a deficiency of oxygen in the upstream portions of the chamber, indicating that these regions are not being used effectively for combustion. There is a good correlation between the temperature and the fuel-air ratio in the combustion zone.

The Blackshear temperature probe proved to be a more convenient and reliable temperature-measuring instrument than the target pyrometer for this application.

The gas-analysis procedure gave consistent and reproducible results for four constituents, oxygen, carbon dioxide, carbon monoxide, and hydrocarbons within ±2 per cent.

Through the use of the temperature-measuring and gas-analysis techniques discussed, valuable design information for use in gas-turbine combustors may be obtained, the paper states. The effect of variation of fuel and air distribution in the combustion chamber on the burner performance may be studied.

Industrial-Types Oil and Gas-Fired Combustion Chambers, by Samuel Letwin, Thermo Projects, Inc., Elmhurst, N. Y. 1952 ASME Annual Meeting paper No. **52—A-128** (mimeographed).

THIS paper discusses the general principles of a type line of combustion chambers for industrial use, and describes the principal design features of five different-type combustors, with performance data of each unit. The paper includes dimensional drawings of each chamber showing pertinent details.

The combustion chamber described consists basically of three members—register, fuel-injection unit, and furnace.

The register consists of those members which set up the air-flow pattern in the immediate zone of the fuel injector. The fuel-injection unit disseminates the finely divided fuel particles into the air-flow stream, while the furnace houses the rapidly burning flame body, providing the required air for completion of combustion but largely supplying dilution air to reduce the outlet combustion-chamber temperature to that desired.

The Periodic-Flow Regenerator—A Summary of Design Theory, by J. E. Coppage and A. L. London, Mem. ASME, Stanford University, Stanford, Calif. 1952 ASME Annual Meeting paper No. **52—A-93** (mimeographed; to be published in Trans. ASME).

A description is given in this paper of the periodic-flow rotary regenerator and it is contrasted to the other types of heat-exchanger systems which may be employed to "regenerate" or "recuperate" the exhaust-gas thermal energy in a gas-turbine plant. The advantages in principle of the periodic-flow type are considered briefly and the mathematical complexities of analysis of the more exact theory of its performance are indicated.

Available special solutions, obtained by numerical-graphical methods, provided by Hausen, Nusselt, Boested, Iliffe, and Saunders and Smoleniec are reviewed and their limitations pointed out. An algebraic-equation solution corresponding to the special case of high rotative speeds is shown to be exactly the same as the well-known equation for a direct-transfer-type counterflow exchanger. These results are supplemented with an "approximate theory" solution which has the advantage of being in closed form, and the limitations on accuracy of this solution are considered.

Recommended design curves are presented using a set of simple nondimensional parameters, of the same nature as those employed for direct-transfer-type exchangers, and which are readily usable for the gas-turbine-regenerator design problem. The curves result from a rational extrapolation of the special case solutions of Hausen, employing the approximate theory as well as the results of Iliffe, to other situations of interest to the gas-turbine designer. An illustrative problem is included.

Fuel-Spray Examination Methods, by F. C. Engel, Jun. ASME, Westinghouse Research Laboratories, East Pittsburgh, Pa. 1952 ASME Annual Meeting paper No. **52—A-139** (mimeographed).

A number of methods of examination of a fuel spray were developed in order to get satisfactory service from a nozzle and in order to find out what makes one nozzle give better results in burning tests than another.

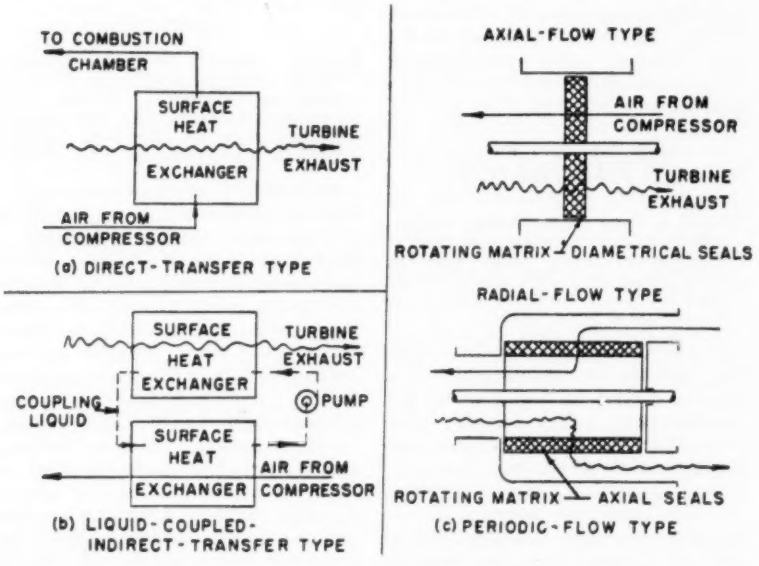
It is pointed out that a new nozzle should be sprayed into the atmosphere before being assembled into a burner. Dissymmetries, excessive eccentricity, and streakiness can be discovered in this manner. These often can be reduced by removal of burrs or dents in the orifice.

Slight dissymmetry of the spray distribution or slight eccentricity do not influence burning efficiency much, the paper states. However, when local dissymmetries exceed 10 per cent of the mean flow rate, an effect on burner performance becomes noticeable.

A fast method of comparing nozzles is to observe their spray angles by the protractor method. With hollow cone nozzles, however, a more reliable way is to determine the angle at which most of the spray is concentrated by use of a sampler across a diametral plane.

A method of finding the spray-droplet-size distribution was described. But differences in such distribution did not materially influence the performance in a burner of otherwise similar nozzles. The burning efficiency was much more sensitive to variations in the spray angle.

All the methods described can be applied equally well to solid cone, duplex, or air-atomizing nozzles. The photographic method might be used for determination of droplet speed or evaporation rate.



TYPES OF REGENERATORS

Fluid Meters

On the Evaluation of the Accuracy of the Coefficient of Discharge in the Basic Flow-Measurement Equation, by Andre L. Jorissen, Mem. ASME, Cornell University, Ithaca, N. Y. 1952 ASME Annual Meeting paper No. **52—A-144** (mimeographed).

THE purpose of this paper is to introduce a discussion on "errors" and "tolerances" in fluid-flow measurement by means of pressure-difference devices, more particularly, by concentric orifice plates, flow nozzles, or Venturi tubes.

The basic flow-measurement equation indicates a relationship between the rate of flow, the geometric characteristics of the primary device, the physical properties of the fluid, and the indicated differential pressure. An evaluation of the accuracy of the measurement is thus based on the analysis of a function of quantities measured independently and the computation of the "error" on the rate of flow is done according to a standard procedure.

Management

The Professional Man and His Lay Patron, by C. J. Freund, Mem. ASME, University of Detroit, Detroit, Mich. 1952 ASME Annual Meeting paper No. **52—A-71** (mimeographed).

ACCORDING to this paper, engineers are perplexed about their professional status, partly because there is no satisfactory standard. There is no compre-

hensive definition of a profession. Exactly what is a profession or a professional man? American engineers should strive that an acceptable defintion be formulated. A principal element in such a definition should be the specification that the professional man shall command the confidence of uninformed lay clients or employers.

Engineers, other professionals, and even philosophers will keep on trying to formulate a completely satisfactory definition of a profession. Ingredients for a definition are gradually accumulating: Individual responsibility, high intellectual activity, motive of service, and the like.

Decision Theory, by R. T. Livingston and D. B. Hertz, Mem. ASME, Columbia University, New York, N. Y. 1952 ASME Annual Meeting paper No. **52—A-106** (mimeographed).

MANAGEMENT is the process of getting things done—the process of making and implementing decisions, according to this paper. The theory of decisioning is an integral part of a theory of management. Decisioning has been described as part of a cycle of continuous action.

It has also been indicated that there are channels of information transfer within an association which constitute a system of feedback circuits. Static and dynamic information energy levels have been demonstrated to represent "only a small fraction of the energy exchange in the system." The decision is the "triggering" element controlling the alternative releases of associational energies. A decision having been made, the results of the decision as indicated by action are fed back and combined with new, or different, information to create a continuous check or governor upon future action.

When decisioning is removed from the conceptual area of flash of genius or automatic reactive process a new basis of analysis is available. It leads to the methodological dimensions in a multidimensional concept of action, in which other dimensions are (*a*) content, i.e., kinds of things, organisms, concepts, perceptions, and the like, and (*b*) sequence, or position variable in a time stream. The process dimension comprises a number of variables: the actual "instant" of decision can be no more than an interval separating specific elements.

It is shown that the process of decision making may be described in terms of: (*a*) Consideration of a problem; (*b*) evaluation of future probabilities (of costs and satisfaction); (*c*) implementation (including an evaluation of probabilities of acceptance); and (*d*) adjustment to reality, in terms of probabilities of acceptance of partial decisions.

The model is shown to be noncategorical and to include various types of probability distributions for costs, satisfactions, and acceptances. The final function is proposed as a model of the decisioning process. Within this model it is now suggested that various kinds of decisioning situations may be described, and that quantitative treatment of the variables and their probability distributions is desirable.

The Modern Theory of Communication, by Brockway McMillan, Bell Telephone Laboratories, Inc., Murray Hill, N. J. 1952 ASME Annual Meeting paper No. **52—A-129** (mimeographed).

THIS paper presents a brief survey of the modern theory of communication. The subject divides broadly into a study of messages and the theory of communication through noise. In studying messages it is necessary to examine the statistics of the universe of possible messages and observe how the statistical structure of this universe may be exploited to provide efficient encoding means for transmitting these messages over an ideal communication medium.

In communicating through noise it is necessary to observe, in addition, the statistical structure of the mutilations or perturbations which signals undergo upon transmission through a realistic communication channel. It is also necessary to attempt to exploit both the statistics of the universe of messages and the statistics of the possible mutilations thereof to devise an encoding means again for efficient transmission of the messages over the channel. In this second case the word "efficient" refers to transmission (*a*) in minimum time and (*b*) with minimum frequency of errors.

Hydraulics

Cavitation Tests on Hydrofoils in Cascade, by Fukusaburo Numachi, Institute of High Speed Mechanics, Tohoku University, Sendai, Japan, 1952 ASME Annual Meeting paper No. **52—A-87** (mimeographed; to be published in Trans. ASME).

IN the field of ship propellers, axial-flow turbines, and pumps, there is a growing demand for higher power and rotative speeds calling for units with larger blade areas and closer blade spacing than have been customary in the past. In designing such machines the problem of blade interference becomes of considerable importance. This is particularly true when considering the cavitation characteristics of these machines.

It is a well-known procedure, when treating such problems, to theoretically intersect the blades of an axial-flow machine with an imaginary coaxial cylindrical-cutting surface and to develop the cross section into a series of hydrofoils arranged in a cascade. This cascade is considered to be infinite in extent and the blade design is based on a series of such sections taken at various radii. Thus the effects of blade interference in axial-flow machines can be studied by investigating the characteristics of various arrangements of hydrofoils in an infinite cascade.

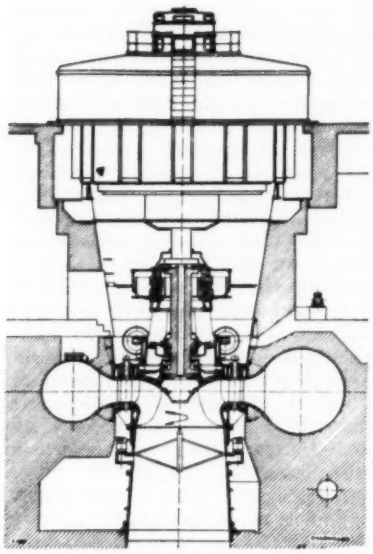
In order to investigate experimentally these characteristics under normal and cavitating conditions and to study cavitation inception, a special cavitation tunnel has been designed and installed in the hydraulic laboratory of Tohoku University, Sendai, Japan. This equipment is used not only to study the effects of mutual interference of hydrofoils but also to investigate the effects of hydrofoil shape or profiles on the characteristics of an infinite cascade.

In conducting this experimental research the cavitation tunnel for hydrofoils in cascade was provided with a balance for measuring the lift and drag specially designed by the author.

The cascade was composed of five test hydrofoils, with chord and breadth both of 100 mm, placed in the measuring section of the water tunnel. The movable upper and lower walls behind the cascade were utilized so as to direct the flow after passing the cascade to conform to the path of an ideal flow through an imaginary set of hydrofoils arranged in an infinite cascade.

Modern Trends in Hydraulic Turbine Design in Europe, by George A. Bover, Charmilles Engineering Works Ltd., Geneva, Switzerland. 1952 ASME Annual Meeting paper No. **52—A-92** (mimeographed; to be published in Trans. ASME).

A GENERAL survey of the hydraulic turbines manufactured in the last 10 to 15 years shows that no major invention has been made in this particular field of engineering in recent years. All the turbines produced still belong to one of the three main types of machines—Pelton, Francis, or Kaplan. Propeller turbines are omitted because they are very seldom made in Europe nowadays, having been completely ousted by the Kaplan turbine. Speaking generally of large turbines, nearly every turbine manufactured in Europe today for heads less than 100 ft is a Kaplan turbine and very few are propeller or Francis turbines. This is because Kaplan turbines, with their smaller dimensions and higher speed of rotation,



ARRANGEMENT OF THE 154,000-HP BORT LES ORGUES FRANCIS UNITS WITH THRUST BEARING CARRIED BY THE UPPER COVER PLATE

are hardly more expensive to install than propeller turbines. They are, therefore, preferred, even when the head and discharge variations are so small, or the number of units so large, that very little gain in power generation is obtained by their use.

Maximum head for which each class of turbine is used has increased gradually. The maximum advance in this respect has been made with Francis turbines, for which the head has risen from 1060 ft to 1490 ft, approximately 40 per cent. In the same lapse of time the advance has been 25 per cent for Kaplan turbines (184 to 230 ft). The advance in Pelton turbines has been only 2 per cent (5700 to 5800 ft) merely because there have not been higher heads to equip.

There has also been a general increase of the specific speed for the higher head turbines, particularly in the field of Kaplan turbines. The highest specific speed has not gone beyond the maximum of approximately 250 rpm reached over 20 years ago with some of the first Kaplan turbines ever built.

Efficiency of the turbines has been improved step by step and has reached the present level of about 93 per cent for Kaplan, 92 per cent for Francis, and between 90 and 91 per cent for Pelton turbines.

The paper also describes and discusses the general arrangement of large hydro-units, the use of high-grade alloys, the efficiency tests of large turbines, various improvements in speed regulation, and departures from accepted practice in the field of gates and valves.

Some NACA Research on Centrifugal Compressors, by Irving A. Johnson and Ambrose Ginsburg, Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1952 ASME Annual Meeting paper No. **52—A-131** (mimeographed; to be published in Trans. ASME).

BASIC aerodynamic requirements of compressors for aircraft power plants include high efficiency, high pressure ratio, large mass flow for a given frontal area, and a large useful operating range. In addition, it is desirable that the compressor be mechanically simple, rugged, and inexpensive to manufacture. Since the centrifugal type of compressor possesses these mechanical attributes, it is apparent that if good aerodynamic characteristics can be obtained, it will have wide application in gas-turbine power plants.

This paper presents a summary of some of the results obtained in the NACA program of aerodynamic research on centrifugal compressors, including both theoretical and experimental aspects. The material presented is not intended to give specific design rules, but is intended to give some insight into the flow processes in centrifugal turbomachinery, to establish general trends of good design practice, and to indicate portions of the field that remain to be explored. The paper covers impeller research, diffuser research, and general aspects of application of centrifugal compressors to aircraft gas-turbine engines.

Steam Power Generation

Corrosion of Mercury Boiler Tubes During Combustion of a Heavy Residual Oil, by A. M. Hall and J. H. Jackson, Mem. ASME, Battelle Memorial Institute, Columbus, Ohio, and D. Douglass, Mem. ASME, Hartford Electric Light Company, Hartford, Conn. 1952 ASME Annual Meeting paper No. **52—A-85** (mimeographed; to be published in Trans. ASME).

THIS paper describes laboratory screening tests of a variety of metallic and ceramic coatings for mercury boiler tubes. These tests showed that coatings of aluminum and of 26 per cent Cr-Fe held considerable promise. Among the ceramic materials, coatings of silica and of magnesia also showed promise. However, ceramic coatings were judged to be too brittle to withstand the mechanical abuse inherent in the service.

Further experimentation, both in pilot-plant tests at Battelle Memorial Institute and in coating tests carried out in the mercury boiler itself, gave results which favored the 26 per cent Cr-Fe coating over the aluminum coating.

These tests, together with several auxiliary experiments, gave indications that the use of a metallic coating on the tubes of the mercury boiler could be practical.

Laboratory results indicated, however, that there was considerable room for improvement in the resistance of the coating to permeation by the gaseous combustion products, as well as in the quality of the bond between the coating and the underlying tubing. The bond between the Cr-Fe coating and the Sicromo 5S tubing was purely mechanical unless the metal was heated to excessive temperatures after deposition. While such a bond appeared generally satisfactory, a diffusion bond would be an improvement.

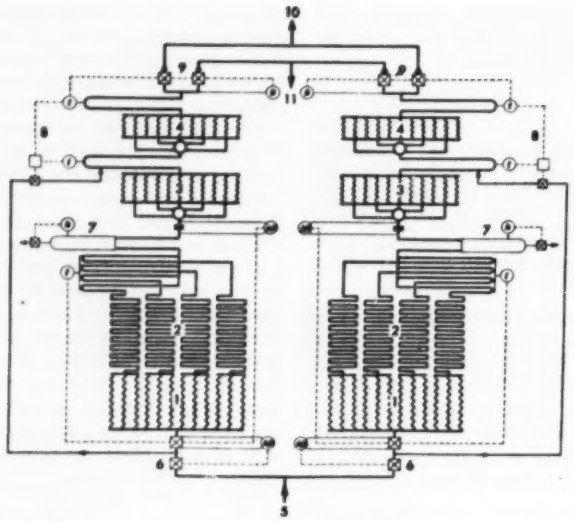
An aluminum coating could be readily diffusion-bonded to the underlying tubing, but the outer layer of aluminum in the coating was often poorly adherent to the diffusion-produced alloy layer between it and the tube.

Attempts were made to decrease permeability and improve bonding by heating the coating subsequent to deposition, by the use of various sealers, such as sodium silicate, ethyl silicate, and asphaltum paint, and by buffing the coating.

Various combinations of metallic coatings were also studied, with regard to improvement of protective quality. A coating of 26 per cent Cr-Fe overlaid with a thin coating of aluminum was found to have some merit. However, heavy multiple deposits tended to be less adherent to the underlying tubing than single deposits.

Among possible fuel additives, the calcium soap derived from tall oil appeared to have many of the properties required of a fuel additive. This compound could be made cheaply and could be dissolved in Bunker-C oil by first dissolving it in kerosene. When added to the fuel oil in the ratio of three atoms of calcium in the tallate to one atom of vanadium in the fuel, it gave a strong indication of being effective in reducing tube corrosion.

European Practice With Sulzer Monotube Generators, by Jacques Gastpar, Sulzer Brothers Ltd., Winterthur, Switzerland. 1952 ASME Annual Meeting paper No. **52—A-121** (mimeographed).



1 ECONOMISER
2 EVAPORATOR
3 CONVECTION SUPERHEATER
4 RADIANT SUPERHEATER
5 FEED-WATER INLET
6 FEED-WATER REGULATORS
7 WATER SEPARATOR
8 SUPERHEATER REGULATING SYSTEM
9 STEAM STOP VALVE AND BY-PASS VALVE
10 STEAM OUTLET
11 BY-PASS OUTLET

DIAGRAM OF A LARGE HIGH-PRESSURE MONOTUBE STEAM GENERATOR
(The tube system can be divided into two separate parts, each being controlled by its own regulating system.)

AT THE end of the first World War, Sulzer Brothers undertook intensive research work with regard to improved economy of steam plants by highest possible working pressures and temperatures. Much experience was gained with high-pressure monotube steam generators in practical service, the paper states.

In 1926 a boiler of the one-drum type went into service at the Sulzer works, which supplied high-pressure steam at 1500 psi for about 15,000 hr. This installation proved satisfactory in service and also in respect of efficiency. However, it was considered doubtful whether the conventional type of boiler with drums and natural circulation, as originally designed for low and medium pressure, was really the best solution in the long run for higher pressures.

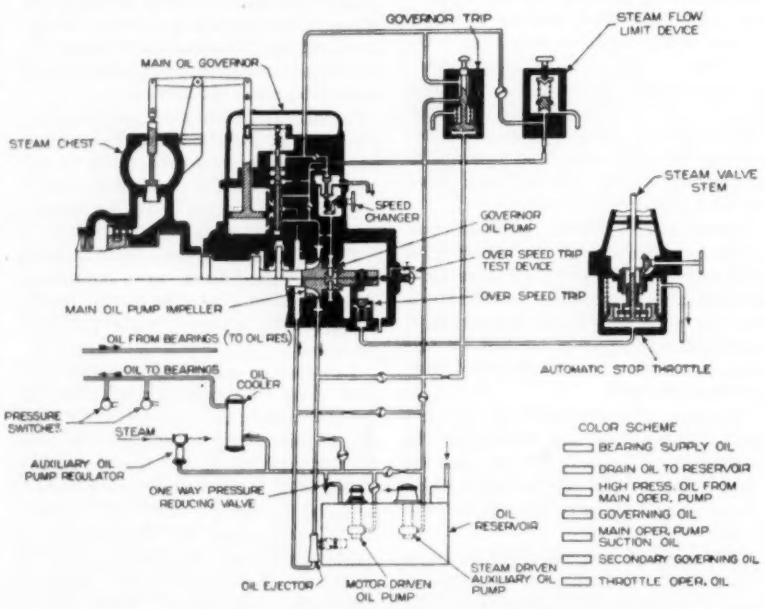
Sulzer Brothers continued their investigations in an entirely different direction and installed an experimental steam generator for the once-through type built for 1400 psi. The company found an entirely new and foolproof way of controlling the forced circulation. Development of high-pressure steam generators along these lines was continued and another experimental unit of 22,000 lb per hr capacity was built. In 1931 orders were received for steam generators of 1500 psi for a dye works and a district-heating plant in Switzerland. These plants, combined with systematic research, proved to be milestones on the road to future developments.

With the drumless steam generator of the once-through type, the high-pressure parts can be reduced to a minimum and are practically limited to the heating surface—to the tube system only. This is a point which may be of considerable importance if difficulties are to be expected in obtaining the necessary material, high-pressure drums, and the like. However, the relative accumulating capacity of the boiler drums decreases considerably with increasing pressure and size of the units. By dispensing with these heavy and expensive parts, the load on the supporting structure is considerably reduced. By installing an independent medium-pressure accumulator in addition to the starting vessel instead of a boiler drum, it is possible to provide at reasonable expense for a practically unlimited accumulating capacity which can be increased at any time.

The designer is given a large measure of freedom in the disposition of the tube system, which can be arranged horizontally, since the use of the effect of the natural buoyancy has been renounced entirely. Outside dimensions of the steam-generator block can, therefore, be kept at a minimum and more easily adapted to special requirements.

Development in Design of Steam Turbine-Generator Lubrication and Control-Oil Systems, by George H. Newton, Mem. ASME, Westinghouse Electric Corporation, Philadelphia, Pa. 1952 ASME Annual Meeting paper No. **52—A-135** (mimeographed).

THIS paper gives a brief history of the development of Westinghouse turbine-



TYPICAL OIL SYSTEM AND CONTROL USED ON WESTINGHOUSE UNITS

generator lubrication and control-oil systems, with emphasis on simplicity of design, appearance, and prevention of oil fires. It also covers the methods of cleaning and protecting parts at time of manufacture, and cleaning of the system after erection.

Design of turbine-lubrication and control-oil piping systems presents turbine designers and power-plant builders with many problems. In the first 20 years of turbine history, builders were not concerned very much with matters of appearance of the turbine-generator installation and protection against oil fires. Steam temperatures were low with relatively little possibility of oil fires, and the control systems were quite simple. Oil piping from bearing pedestals was run above the operating floor level. Steam chests and servomotors were mounted on this level or on the turbine casing cover. Oil reservoirs were located directly in front of the turbines and just low enough below the operating floor level to provide a reasonable slope in the oil return lines for oil drainage.

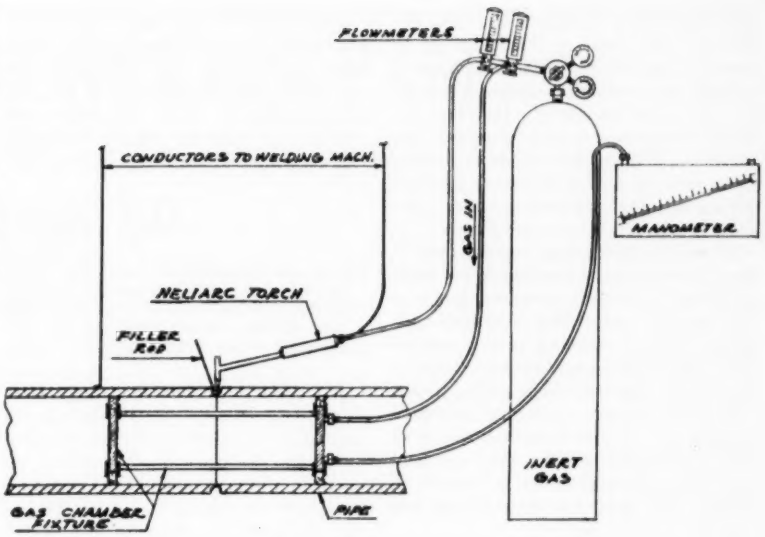
In the late 1920's horizontal runs of oil piping were hidden by running them in trenches in the foundation deck or by taking them below operating floor level through pipe sleeves arranged in the foundation deck. Vertical runs of piping to the inlet and outlet connections on the bearing pedestals were still very much in evidence.

At about this stage of turbine design larger units with larger oil flows were being built. Troubles were experienced with oil leakage at shaft seals, oil vapor, and oil foaming. One of the causes for these troubles was determined to be insufficient area in the oil return piping from the bearing pedestals. The enlarging of these lines necessitated lowering this piping in order that the proper bends could be made and reasonable flexibility could be obtained. This in turn put the oil reservoir at a lower level.

From that point progressive advancement has been made to today's arrangements where very little of the oil piping is above the operating floor level and the oil reservoir is quite remote from the turbine and may even be in a fireproof room at basement level.

Controlled Internal-Contour Shielded-Root Welds Without Backing Rings, by Charles Diehl, H. S. Blumberg, and W. G. Benz, Jr., The M. W. Kellogg Company, Jersey City, N. J. 1952 ASME Annual Meeting paper No. **52—A-141** (mimeographed).

SINCE the inception of fusion welding, its application to the joints of small-diameter cylinders or otherwise inaccessible interior surfaces, so as to be of a quality comparable in all respects to double "V" welds, has remained a major problem, according to this paper. With oxyacetylene welding the exceptional operator is able to maintain significant but not complete control of penetration. With electric arc welding it has been necessary to resort to chill or backing rings for reasonable assurance of a complete weld.



GENERAL ARRANGEMENT OF WELDING EQUIPMENT

With the introduction of nonconsumable electrode-gas-shielded arc welding, the superior operator control afforded by gas welding and the higher heat input and concentrated heat energy of arc welding are simultaneously realized. Inert gas further provides the molten and hot metal protection against the atmosphere, and gases released during welding. With the application of conventional inert-gas shielding to the interior surface of the root bead, complete welds essentially free of oxide are achieved. With outstanding operator skill, reasonably complete penetration can be attained without backing rings. Maintenance of this level of performance, however, involves operator physical strain. Nondestructive examination is of limited usefulness in detecting lack of penetration.

By the precise control of technique, physical dimension, and auxiliary shielding gas pressure, K-Weld with average operator ability produces root welds of assured full penetration and controlled contour, uniform root-bead surface free of undercutting, and the desired degree of root-bead overlay, without the use of backing rings. This process, which is the subject of this paper, has been successfully applied to the difficult fabrication of $9^1/_{\overline{2}}$-in-OD × $1^5/_8$-in. wall austenitic Type 347 utility main-steam pipe lines for 1100 F and 2350 psi service, and other involved applications. It is effective not only on pipe welds, but also on many fabrication operations on other pressure equipment.

Weld quality obtained by this process easily meets all x-ray, physical, and mechanical requirements of the ASME Boiler Code, and other codes and specifications. Tensile, bend, impact, and torsion tests have demonstrated excellent properties and in combination with micro and macro examination show no tendency for crack formation, or undercut at the edges of the inside bead.

Large Steam Turbine-Generator Lubricating Systems, by James J. Gibney, Jr., Jun. ASME, General Electric Company, Schenectady, N. Y. 1952 ASME Annual Meeting paper No. **52—A-152** (mimeographed).

THE lubricating system for large steam turbine-generator units consists basically of an oil-storage tank, an oil pump, and oil feed and drain piping between the rotating equipment and the oil tank. The lubricating system should be as simple as is possible, limited only by the considerations that it be reliable and that it not be subject to fires, according to this paper. Simplicity sometimes must be sacrificed in order to meet satisfactorily all considerations.

Lubricating oil will flash into flames if it is sprayed on a surface whose temperature is above 675 F. A fire fed by oil

spraying from a pressure source can destroy a power station. It therefore is obvious that oil piping in the vicinity of high-temperature turbine parts should be kept to a minimum. However, as steam temperatures and pressures are increased, and the reheat type of turbine cycle is utilized, this intermixing of oil piping and high-temperature metal surfaces is unavoidable to some degree.

However, protection against fires is far from the only consideration when designing a turbine-generator lubricating system. Providing a reliable oil-pump system, reducing piping congestion, eliminating interferences, arranging for proper slopes to drain piping, locating and housing necessary auxiliary equipment—all are important and must be properly designed so that the final product is molded to fit in the power station and will give reliable and safe service.

The oiling system for steam turbine-generator units not only supplies the lubrication that supports the powerful high-speed rotors, but it also serves as the nervous system and muscle for controlling and operating the governing apparatus.

This paper describes the development of the lubricating system and some of the associated equipment used on General Electric units in ratings of 20,000 kw and above. Included are the piping practices followed by G.E. to provide the greatest possible safety against fire.

Also described is the protection available for hydrogen-cooled generators to prevent possible oil-reservoir explosions.

Recent Developments in the Use of Pellets for the Removal of Slag Deposits in Boiler Furnaces, by W. F. Cantieri, Mem. ASME, Diamond Power Specialty Company, Lancaster, Pa. 1952 ASME Annual Meeting paper No. **52—A-163** (mimeographed).

AFTER a brief historical summation, this paper traces the development of a feeding mechanism for the projection of pellets at high velocity into a furnace for the removal of slag. It reviews the several means which so far have been tried in the application of this pellet feeder to removing slag from boiler furnaces. It describes the effect of the variables in the pellet-projecting device on the pattern and penetration of the pellets at various distances from the device. Velocity of pellets, feed rates, and pellet materials are among the functions described.

The pellet-type deslagger has been installed in enough furnaces to show that it effectively will remove slag when it can be brought to bear at distances up to 35 ft. Pellets are available which do no damage to the heating surface and which practically destroy themselves after they have removed the slag. Economics of the pellet-type deslagger have not yet been developed. Where the pellet gun will do a cleaning job not possible with other cleaning media, it will be necessary to balance pellet costs against the cost of a boiler outage. Where the pellet gun assists other media, many more tests will need to be run to determine the economic balance between the various media. Continued work is being done to develop this phase of pellet-type slag removal.

Oil and Gas Power

Crankcase Explosions Can Be Contained, by R. O. Montenero, Jun. ASME, Fairbanks, Morse & Company, Beloit, Wis. 1952 ASME Annual Meeting paper No. **52—A-136** (mimeographed).

RESULTS of a development program directed to eliminating the damage resulting from occasional crankcase explosions are discussed in this paper. It includes a brief review of the theoretical aspects of an explosion, a description of the engine design modifications, experimental tests, and field experience with the new design.

From the test work described, the following conclusions were reached: (1) With all engine conditions normal except for a "hot spot" in the crankcase, the peak pressure developed by a primary explosion will not exceed 20 psig. (2) Varying the oil temperature from 160 to 230 F had no important effect on the maximum explosion pressures developed. Also, an explosion with 270 F lube-oil temperature did not result in any explosion damage.

Fairbanks, Morse & Co. has in operation approximately 100 engines which have incorporated this explosionproof design and the oldest have been in railroad service for $2\frac{1}{2}$ years. Even though several of these units have had internal part failures which ignited the crankcase vapors, not one of these 100 units has either blown off a cover or suffered any explosion damage, the paper states.

ASME Transactions for March, 1953

THE March, 1953, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

Topics in Gyroscopic Motion, by H. Poritsky.

Stability Criteria for Forced Vibrations in Nonlinear Systems, by K. Klotter and E. Pinney.

Rails on Elastic Foundations, by H. E. Criner and G. D. McCann.

Stability of Thin Elastic Plates, by G. A. Zizicas.

Effect of Surface Condition on Creep, by E. D. Sweetland and E. R. Parker.

The New Approach to Shell Theory, by E. H. Kennard. (52—F-9)

Forced Oscillations of the Centrifugal Pendulum, by F. R. E. Crossley. (52—F-11).

A Nondestructive Test for Thin Shells, by J. C. New. (52—F-10)

Analysis of Forced Vibration of Beams, by N. O. Myklestad. (52—F-12)

On Asymmetric Flow in Axial-Flow Compressor Stage, by W. R. Sears. (52—F-15)

Turbulent Mixing of Two Parallel Streams, by T. P. Torda, W. O. Ackermann, and H. R. Burnett. (52—F-14)

Some Problems of Orthotropic Plane Stress, by H. D. Conway. (52—A-4)

The Bending of a Wedge-Shaped Plate, by S. Woinowsky-Krieger. (52—A-6)

Stress Distribution Under Concentrated Loads, by H. D. Conway. (52—A-14)

The End Problem of Rectangular Strips, by G. Horvay. (52—A-2)

Nonlinear Distribution of Bending Stresses by H. H. Bleich. (52—A-7)

Necking and Rupture of Rods Under Tensile Loads, by N. J. Hoff. (52—A-12)

On Turbulent Flow Between Parallel Plates by S. I. Pai. (52—A-5)

Analogue to High-Velocity Combustion, by A. K. Oppenheim. (52—A-3)

Elastic Waves Created During Tensile Fracture, by Julius Miklowitz. (52—A-10)

Influence Coefficients of Tapered Cantilever Beams Computed on SEAC, by Samuel Levy. (52—A-25)

DESIGN DATA AND METHODS

On the Maximum Numerical Value of the Tangential Stress in Thick-Walled Cylinders, by T. Ranov and F. R. Park.

Stresses in Curved Beams—A Tabular Method of Solution Based on Winkler's Theory, by W. Wright.

BRIEF NOTES

Movies of Stress Waves in Photoelastic Rubber, by H. C. Perkins.

Bending of Clamped Wedge Plates, by Herbert Reismann.

DISCUSSION

On Previously Published Papers by F. R. E. Crossley; W. J. Carter and J. B. Oliphint; M. Feigen; J. Gallagher and E. Volterra; L. Green, Jr.; R. Holm; J. Kaye, J. H. Keenan, K. K. Klingensmith, G. M. Ketchum, and T. Y. Toong; T. C. Lee; C. M. Tyler, Jr., and J. G. Christiano; E. H. Lee and P. S. Symonds; and E. H. Lee.

BOOK REVIEWS

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Lubricating Machine Tools

COMMENT BY R. J. BROSSMANN[1]

Most of the physical specifications as set forth in the paper[2] are of no consequence in the performance of a lubricating oil in many of its applications. As examples, color, flash, and fire point have little or no bearing upon the functional properties in machine-tool application. The same also may be said of carbon residue where the oil is well refined and obtained from a reputable oil company.

Without commenting further on some additional specifications, we might state that the resistance to oxidation, the presence of a rust inhibitor, proper viscosity at the operating temperature with good film strength to prevent metal-to-metal contact, are the most important properties to look for in a lubricating oil. As a matter of fact, it has been demonstrated by laboratory investigation that two oils may be selected having identical physical specifications and yet the functional properties of these oils may differ greatly from a standpoint of protection against wear, change in viscosity, and accelerated oxidation.

We might consider two oils, one an SAE 20 grade and another an SAE 30 grade and inspect the viscosities of these oils at various temperatures such as would be determined by their viscosity index. The characteristics of such oils are given in Table 1.

TABLE 1 CHARACTERISTICS OF SAE 20 AND SAE 30 GRADE OILS

SAE no.	Viscosity index	Viscosity at 100 F	110 F	120 F	130 F	210 F
20	70	350	260	200	157	52
	90	310	240	185	148	52
30	70	580	398	300	230	62
	90	501	375	284	220	62

It is to be realized that many solvent-refined oils are available today which have relatively high viscosity indexes. However, comparing the two oils mentioned, it will be noted that there is relatively little difference in the viscosity, particularly as we approach higher temperatures. We have discussed lathe-head-stock lubrication with one manufacturer who has stated that temperatures do not normally exceed 120 F. It will be seen from Table 1 that where a difference of some 20 points in viscosity index may exist, the viscosity itself at 120 F differs only some 16 sec. It is our firm conviction that this difference will have no bearing upon the proper lubrication of the head stocks, and as mentioned before, only the proper viscosity at the operating temperature, resistance to oxidation, and film strength, are of major importance. Furthermore, all of the specifications given by the author for use in an automatic lubricator have no significance in an all-loss system with the exception of viscosity and its attendant film strength to prevent metal-to-metal contact.

It may be stated that the importance of viscosity index is recognized in a hydraulic oil. This requirement is not noted in the specifications as set forth by the author.

COMMENT BY C. L. POPE[3]

The author should be complimented for demonstrating so well how the various machine-tool builders have provided adequate lubrication means for all moving surfaces. The specifications for the lubricants to be used as specified by the various builders are confusing, meaningless, and work a hardship in the plants having a variety of machine tools, in that one could not possibly meet all of the builders' specified lubricants by any practical means.

Parallel surfaces where thick-film lubrication cannot be maintained must have polar compounds or so-called way lubricants, irrespective of what machine the parallel surfaces are on. Precision spindles only have limited temperature rise and, therefore, viscosity is all important. Gear cases will operate on a wide variety of oils and viscosity. In spite of these common lubricant requirements, let's recall some of the specifications.

One calls for gravity of the oil, which is of no interest to the consumer, but is a refinery control. One or two call for initial acid number of a low value. With the increasing use of additives, it is perfectly possible to have a good oil with initial acid number of 2.0 or more. It is not believed that there is any correlation between acid number and oil performance of different oils. Others recommend an oil change at a given acid number, say, 0.4. Now, with some oxidation-inhibited oils, such as a good hydraulic oil, a change in acid number from 0.05 to 0.15 indicates that the inhibitor is gone and the oil should be changed.

To sum up, it would appear that machine-tool builders are trying to write quality and a standard control into their lubrication recommendations. This, in the writer's experience, is impossible. The writer would suggest that the tool builders get together and decide the following: What viscosities and types of oils are required, and then leave the quality as a responsibility of the supplier. The following is an example for all hydraulic systems:

Viscosity SUS at 100 F	Grade
140/160	Turbine or hydraulic
280/320	Turbine or hydraulic
450/600	Turbine or hydraulic

The viscosity selected for any one system, of course, would be dependent upon type of pump and characteristics of the system. All reputable suppliers of lubricants know what is required of a hydraulic or turbine grade of oil.

AUTHOR'S CLOSURE

It is quite true, as pointed out by Mr. Brossmann and Mr. Pope, that some of the physical specifications listed in the lubrication recommendations of some machine-tool builders are of no consequence for their applications.

This paper is the result of a survey of many of the major machine-tool builders. From it we see that machine-tool engineers have made great strides in increasing the productivity of their machines. Likewise we see that they have given much thought to ways and means to provide proper and adequate lubrication.

[1] Engineer, Engine Building Division, Socony-Vacuum Oil Company, Inc., New York, N. Y.

[2] "Modern Machine-Tool Lubication Practices," by W. D. Whalen, MECHANICAL ENGINEERING, vol. 74, October, 1952, pp. 803–809.

[3] Lubricating Engineer, Eastman Kodak Company, Rochester, N. Y. Mem. ASME.

However, because of the shortage of qualified lubrication engineers the recommendation of lubricants is usually a duty of the chief engineer or designer, who usually does not have time to delve into the theory and science of lubrication. So he calls in several oil-company engineers for advice as to the lubricant to recommend.

Some chief engineers, visualizing all the possible remote areas where their machines might be sold, feel that they should not recommend a "brand-name" oil. They will ask for the physical specifications of the oils suggested by the oil-company engineers. These they might consolidate into a general specification so that a customer can secure an oil that would be satisfactory from several sources.

Other chief engineers feel that it is more satisfactory to recommend a brand-name oil and let the customer use this as a guide for the lubricant he wishes to choose.

We can well appreciate that this procedure does work a great hardship in large plants having a great variety of machines. It is a problem that machine-tool builders recognize but do not know how to solve by themselves.

Mr. Pope's suggestion that machine-tool builders get together and decide the viscosities and types of oils required and then leave the quality as a responsibility of the supplier would be a step in the right direction. However, we do not believe it goes far enough. The machine-tool builder should give some indication of the quality of the oil to use for a given application.

All of the major oil companies check periodically with machinery manufacturers and list the lubricants recommended for various machines. Copies of these recommendations are supplied by the oil companies to their field service men. When an oil company is called in to supply the lubricants for a machine tool, they will first check their list of recommendations before suggesting the oil to supply.

The machine-tool customer may not necessarily follow the manufacturer's recommendations, but may use a higher-quality or a lower-quality oil as he chooses. However, it should be the responsibility of the machine-tool builder to his customer to indicate the quality of the oil to use and not a responsibility of the oil supplier.

From the machine-tool builder and user's point of view, we believe that this problem could be greatly simplified if some national organizations, or a group of the major oil-producing companies would set up a standard code system for the various types, qualities, viscosities, and so on, of oils. The code number could include the viscosity—viscosity index—and a letter or number designation for the various inhibitors added, and any other feature indicative of performance.

The code system could be something on the order of the system adopted by the steel industry to classify steels as to their chemical composition. The machinery manufacturer could then designate on their machines, and in their instruction manuals, the type and quality of lubricant recommended by means of a simple code number. The customer and the oil supplier would know the type and quality of oil recommended by this number regardless of in what section of the country they might be located.

W. D. WHALEN.[4]

[4] Plant Engineer, R. L. LeBlond Machine Tool Company, Cincinnati, Ohio.

Stronger Engineering Graduates

TO THE EDITOR:

I have read the article in the November, 1952, issue of MECHANICAL ENGINEERING titled "Stronger Engineering Graduates," by Gilbert E. Doan. This is a fine paper and I believe the idea is a good one. However, in my opinion, there is need to bring into the classroom discussions experts in the disciplines in which the engineer is not an expert. For example, every man who achieves prominence is likely to be either considered an authority in government, economics, sociology, and education, or he professes to be one. We engineers are guilty of the same assumptions. We engineers who live in the universities discover that the professors in these several controversial fields have knowledge and criteria for judgment which give them authority far beyond our own. My question lies in this area. Are the knowledge and authority of specialists in these fields made available to the students in their discussions—not in every meeting but at critical points? In instruction there need be no prohibition against technical discussion of any form of government, provided the facts are presented and the defects are given proper emphasis.

In this age when the threat of communism and totalitarian government generally is so real, we shall be obliged for the safety of our country to justify the type of instruction that is being given in terms of the communist threat. To my mind this threat is real and should be combatted, but it would be a mistake to leave the student on the defensive. The discussion should include, I believe, positive factors such as the best men in political science, sociology, and education can bring to mind from the history of our own country's development. I believe that this can be done without indoctrination in the invidious sense and I rejoice to note that the students report that they did not construe the discussions as "subject to indoctrination." I pass these comments on for whatever purpose they may serve.

BALDWIN M. WOODS.[5]

MR. DOAN'S REPLY

To the Editor:

Professor Woods's comments throw valuable light on the development of engineering students. I will try to answer his questions by citing an actual experience.

The question arose in conference, "Is socialized medicine desirable for this country or would it rob men of personal responsibility and lead toward socialism?" One of our guest conference leaders was a surgeon. He opposed it. The next guest was a national figure in Washington. He favored it strongly. Both gave good reasons. Both are authoritative experts and unselfish men. If the conference attempted to reach a decision on which all specialists agree, we would spend the rest of the term at it. And even then there would be a wholesome division of opinion in the group.

EXPERTS DISAGREE ON BROAD QUESTIONS

Out of our discussion there does emerge gradually a group of unshakable convictions. These include:

1 Reason, justice, mercy, and truth are the foundations of the Western way of life. We don't live in a chaos, but in a cosmos. A student should ground his life on these ideals, not on specialized knowledge which changes rapidly. But no "expert" can prove a man ought to be just rather than unjust. It is a matter of *faith*.

2 A college man has received privileges of hereditary endowment, good rearing, free schools, endowed universities, and liberty to which he, as an in-

[5] Vice-President, University Extension; Professor of Mechanical Engineering, University of California, Berkeley, Calif. Fellow ASME.

dividual, did not in any way contribute. *He owes a debt to society.*

3 His solution of the socialized medicine proposal, *if made with justice and mercy as his guide*, is his own business. But if he lets his pocketbook govern his vote he is a traitor to basic justice *as he sees it.*

This is a clear and worthy view of life. It makes sense. It is the American way of life in action. As long as each man pursues transcendent ideals he can be "released into the custody of his own conscience." The idea that even the best of experts can give final answers to broad questions sounds like totalitarianism. In such a setup the experts, "men of knowledge and authority," make the final decisions. The police squad enforces them. This is the mistake made at our universities in believing that experts can make our decisions for us, and that we can forget about ideals if we just have enough specialists.

Our seniors have had courses with specialists in history, government, and economics before they come to the senior conferences. Since these specialists often disagree, the student is confused. The purpose of our conference plan is to encourage each man to bring together into a focus the views he has been most receptive to, and to work out a rational life-view *of his own*. We advocate that as foundation he adopt reason, justice, mercy, and truth, since our way of life grew out of belief in these ideals. But beyond that he is on his own.

To come back to Professor Woods's question now and answer it specifically: Yes, we do have specialists as guest leaders of the conference. They disagree. Therefore a unified outlook *cannot* be built on specialized knowledge and expert advice. Men must build on faith in transcendant ideals. The alternative is the police state.

GILBERT E. DOAN.[6]

[6] Manager, Metallurgical Research, Koppers Company, Pittsburgh, Pa.; formerly professor of Metallurgy, Lehigh University.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Statistics

STATISTICAL THEORY WITH ENGINEERING APPLICATIONS. By A. Hald. John Wiley and Sons, Inc., New York, N. Y.; Chapman and Hall, Ltd., London, England, 1952. Cloth, $6^1/_4 \times 10$ in., tables, figs., author index, index of symbols and formulas, subject index, xii and 783 pp., $9.

STATISTICAL TABLES AND FORMULAS (Wiley Publications in Statistics). By A. Hald. John Wiley and Sons, Inc., New York, N. Y.; Chapman and Hall, Ltd., London, England, 1952. Paper, $8^1/_2 \times 11$ in., 98 pp., $2.50.

REVIEWED BY F. A. MCCLINTOCK[1]

WHILE the production engineer has been making increasing use of statistical methods in inspection and quality control, research and development engineers have made little use of statistical methods in their work. The data obtained in experimental work are usually few enough so that all points can be reported in tabular or graphical form. The average value of a series of readings or a least-squares fit of a line is usually the only treatment the data are given. But the data are rarely interpreted to answer such questions as "What values might be obtained if this experiment were to be repeated?" or "If I design similar parts, how many of them will have a performance above such and such a standard?" or "The average value is the best estimate, perhaps, but how far might that be from the 'true' value?" Probably the reason that most engineers do not answer these questions is that they do not know that it is possible to answer them, especially when there are only a few observations, perhaps even only two.

The author's aim is "to provide a fairly elementary mathematical treatment of statistical methods of importance to the engineer in his daily work." He assumes a knowledge of only standard differential and integral calculus. He is of course not able to present all methods even within the 800 pages of the book. In fact, the principal drawback to the book is its size, even though it has a symbol and formula index in addition to the usual subject and author indexes. The statistical novice, unless he has great determination, would do well to read first one of the recent shorter introductions to mathematical statistics in order to get a briefer survey of the field.

The title of the book may, at first glance, be deceiving. One might expect to find a vast store of engineering problems with their statistical solution, a kind of experiment handbook. Dr. Hald, in his last chapter which might well serve as his first, cautions against this very idea. The fact that the engineering problems used for illustration can be solved by statistical methods might lead to an unwarranted optimism concerning the universality of their successful application. The failure, as a consequence, of the application of standard statistical methods to new situations or experiments must not lead to a rejection of the whole field of statistical methods. Rather, the fault may be in the failure of the assumptions underlying the method to meet the particular conditions of the experiments. This means that the engineer must be sufficiently familiar with the theory to recognize this and, if necessary, to develop his own methods. It is for this reason that the emphasis in the book is on the statistical theory rather than on the engineering applications.

Dr. Hald first discusses probability and its applications, and then turns to the tabulation and description of observations of continuous variables. This in turn leads to the idea of the population of all possible observations, described by a mathematical function called the frequency distribution. The statistical theory that follows is developed mainly for the normal, or Gaussian, frequency distribution.

Among the many problems discussed by the author and not usually found in intermediate texts, the following may be of special interest to the research and development engineer.

Sometimes data are incomplete in that some of the observations are only described as being below a certain value (a censored distribution) or are omitted entirely (a truncated distribution).

[1] Assistant Professor, Mechanical Engineering Department, Massachusetts Institute of Technology, Cambridge, Mass. Jun. ASME.

Methods are given for analyzing the observations and estimating the population from which they came under these conditions.

Introductory books usually deal principally with estimating a typical value of the population from which the observations were made. The engineer is frequently interested, however, in determining that all, or at least the largest fraction, of his product will meet certain requirements. In statistical terminology, he is interested in determining above what limits a certain fraction of the population might reasonably be expected to lie. The statistical answers to this problem are given in the section on tolerance limits.

In experimental work, one occasionally encounters one observation which differs widely from others presumably similar. He then wonders whether there was some gross error, or whether these results were due solely to the normal scatter. Help in reaching a decision is given by Dr. Hald's discussion of several criteria for rejecting outlying observations.

A familiar problem is that of fitting a straight line to experimental data in some optimum manner. Dr. Hald describes the usual least-squares technique, and then goes on to show how far the line that best fits a finite number of observations may be from the "true" line which best fits the population of all observations.

In estimating the fraction defective of a population by partial inspection, a theory is frequently used which requires the arbitrary assumption that all fractions defective are equally likely. The author describes the application of the technique known as setting confidence levels. By choosing a probability that the estimates made according to this scheme will be right, the necessity for the a priori assumption that all fractions defective are equally likely can be eliminated. It should be mentioned, however, that the method only gives estimates of the fraction defective such that the probability of these estimates being right may be slightly greater than, as well as equal to, the level given in his tables.

One of the virtues of the book is that in a case such as this, or if one wishes to pursue a subject further, or get a more detailed derivation, his task is made easier by complete and descriptive references to the literature.

The modern engineer must add this field of mathematical statistics, so thoroughly presented by Dr. Hald, to those comprising his area of knowledge if engineering progress is to keep pace with the growth of modern science and fulfill its mission of translating research into practice for the greater good of mankind.

Books Received in Library

AIRCRAFT INSTRUMENT DESIGN. By W. H. Coulthard. Sir Isaac Pitman & Sons, Ltd., London, England, 1952. Bound, $5^3/_4 \times 8^3/_4$ in., 309 pp., charts, diagrams, illus., 40s. This text, intended for advanced students, explains in detail the basic principles on which the design of aircraft instruments depends, and illustrates these principles by drawings and photographs of typical instruments. The instruments are classified and divided into four sections: the pilot's instruments; the navigator's instruments; the flight engineer's instruments; automatic-flight instruments. Diagrams, graphs, and mathematical derivations are extensively used to develop and amplify the explanatory material.

ATMOSPHERIC POLLUTION. Its Origins and Prevention. By A. R. Meetham. Pergamon Press Ltd., London, England, 1952. Bound, $5^1/_2 \times 8^1/_2$ in., 268 pp., charts, diagrams, illus., tables, 35s. This book treats the whole subject of fuel pollution in Great Britain—principally in the forms of sulphur dioxide, smoke, and ash. It goes into the subjects of fuels, fuel-burning appliances, and industrial processes, besides giving information on the measurement, distribution, and effects of atmospheric pollution. Remedial measures are also considered, together with some legislative measures in England and the antismoke laws in the U.S. The nontechnical approach of this book renders it useful to a variety of interested groups.

AUTOMATION. The Advent of the Automatic Factory. By John Diebold. D. Van Nostrand Company, Inc., New York, N. Y., 1952. Bound, $6 \times 8^1/_4$ in., 181 pp., $3. "Automation" denotes not only automatically controlled operation, but also such aspects as product and process redesign for automatic operation, the theory of communication and control, and the design of specialized machinery, the whole being viewed as a distinct area of industrial endeavor. This book is not intended to be a contribution to technological knowledge, but is primarily an essay on the business problems of automation and indicates how technological developments can be useful to the businessman. It points out the obstacles and limitations as well as the possibilities of automation; suggests solutions for problems which arise; describes existing examples of partial achievement; evaluates computers and their application to production scheduling, unit-operations analysis, and similar control procedures; and discusses the important economic and social effects of the new technology.

DIE DREHSCHWINGUNGEN IN KOLBENMASCHINEN. By Kurt Haug. Springer-Verlag, Berlin, Göttingen, Heidelberg, Germany, 1952. Paper, $6^1/_4 \times 9$ in., 201 pp., charts, diagrams, illus., tables, 24 Dm. This treatment of torsional vibration in reciprocating engines is intended for both the student and the practicing engineer. The three major sections are as follows: fundamentals of mechanical vibrations, and the mathematical analysis of torsional vibration systems; calculation of torsional vibrations in reciprocating engines; design of reciprocating-engine plants with regard to torsional vibration, and discussion of preventive measures.

ÉQUIPEMENT THERMIQUE DES USINES GÉNÉRATRICES D'ÉNERGIE ÉLECTRIQUE. By J. Ricard. Dunod, Paris, France, second edition, 1948, new printing 1953. Bound, $6^3/_4 \times 9^3/_4$ in., 658 pp., charts, diagrams, tables, 4400 fr. A thorough, over-all treatment of the thermal equipment of steam plants for generating electricity. It covers steam cycles, heat transfer and heat exchangers, fuels and combustion, steam boilers, boiler furnaces, combustion calculations, feedwater treatment, combustion control, steam turbines, condensers, and other auxiliary equipment. Separate chapters are devoted to special topics such as the economics of steam generation, interconnected plants, stand-by plants and accumulators, and the selection of steam cycle and equipment. There is a bibliography.

THE EXPLORATION OF SPACE. By Arthur C. Clarke. Harper & Brothers, New York, N. Y., 1951. Bound, $5^3/_4 \times 8^1/_4$ in., 199 pp., diagrams, illus., $3.50. Written to answer the questions of the intelligent layman, this book provides a nontechnical but scientifically accurate treatment of the field of "astronautics." It deals with rocket propulsion, escape velocities, the requirements of a space ship, refueling stations in free orbit around the earth, and space navigation. It describes briefly the characteristics of the moon (including a hypothetical lunar base), the inner and outer planets, and other possible solar systems. Consideration is given to the engineering, medical, and physical problems connected with space travel, and its possible significance to civilization is discussed.

FATIGUE AND FRACTURE OF METALS. Edited by William M. Murray. John Wiley & Sons, Inc., New York, N. Y., 1952. Bound, $6 \times 9^1/_4$ in., 313 pp., tables, graphs, illus., charts, $6. The fourteen papers which make up this book were presented as a symposium at M.I.T. in June, 1950, by specialists in various aspects of the field. The subject matter came within the following major categories: general experience with failure of metals; specific fields in which it occurs; the internal mechanisms probably involved; significance of various metallurgical phenomena to fatigue; the potential usefulness of different research methods in investigating the fatigue condition and for countering it in design; the direction of future research. The over-all object was to consolidate existing knowledge of the phenomena and the major problems involved.

HANDBOOK OF AERIAL MAPPING AND PHOTOGRAMMETRY. By Lyle G. Trorey. Cambridge University Press, New York, N. Y., second edition, 1952. Bound, $6^1/_2 \times 10$ in., 180 pp., charts, diagrams, illus., tables, $6. This manual, intended for the drawing office, describes a variety of techniques for making maps from air photographs. The methods described are mainly the newer ones developed during and since the war. Procedures, calculations, and instruments are covered in logical order in a step-by-step manner. Appendixes contain a detailed presentation of the standard mapping procedure of the Royal Canadian Engineers, additional notes on the multiplex

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and stereoplanigraph, and a brief account of the Kelsh plotter.

INVESTMENT CASTINGS FOR ENGINEERS. By Rawson L. Wood and Davidlee Von Ludwig. Reinhold Publishing Corporation, New York, N. Y., 1952. Bound, 6½ × 9¼ in., 477 pp., charts, illus., tables, $10. A comprehensive description of the important features, advantages, and limitations of investment-casting processes. The book covers the making of patterns and dies, investment materials and techniques, melting and casting methods, selection of alloys, finishing and inspection operations, metallurgical limits, and tolerance control. The emphasis throughout is on design engineering factors and on the industrial application of the process. Considerable space is devoted to the fields of use of investment castings, and special topics such as the metallurgy of small cast parts and machinability tests are included.

KORROSIONSTABELLEN METALLISCHER WERKSTOFFE. By Franz Ritter. Springer-Verlag, Vienna, Austria, third edition, 1952. Bound, 6¾ × 9¾ in., 283 pp., charts, tables, $8.20. Tables of the corrosion of metallic materials arranged by the German name of the attacking substance. The corrosive effects are expressed in grams per square meter per day and millimeters per year. In addition to the main section of tables, the book includes an introduction to the use of the tables, a numerical index to the more than 900 metallic materials considered, an extensive list of original literature sources, and a supplement containing information not given in the main tables. A considerable amount of new information has been added in this edition.

NONFERROUS PHYSICAL METALLURGY. By Robert J. Raudebaugh. Pitman Publishing Corporation, New York, N. Y., 1952. Bound, 345 pp., illus., tables, diagrams, charts, $6.50. Arranged according to the metals considered, this book devotes separate chapters to aluminum, magnesium, copper, nickel, and their alloys; a chapter to the alloys of cadmium, lead, tin, and zinc; and a chapter to the precious metals and such minor metals as beryllium, molybdenum, tungsten, and so on. Particular emphasis is placed on recent developments in their processing, fabrication, and application: melting and casting of reactive metals such as molybdenum, direct casting of billets of aluminum and magnesium, and the fabrication of ductile titanium are examples. A special chapter covers powder metallurgy and refractory-metal composites.

MAJOR FAULTS ON POWER SYSTEMS. (Monographs on Electrical Engineering, volume 13.) By A. G. Lyle. Chapman and Hall Ltd., London, England, 1952. Bound, 5¾ × 8¾ in. 355 pp., illus., diagrams, charts, tables, 45s. This monograph, written by an authority in the field of electric-power supply, is a critical examination of the behavior of power systems under fault conditions, and should prove especially useful to practicing engineers. The author investigates the origins, the effects, and the magnitudes of currents and voltages of lightning and switching surges, and some of the phenomena associated with failures of insulation. At the same time, protective equipment such as surge-arrestors, absorbers, suppressors, relay systems, and circuit-breakers are discussed. Some representative problems are worked out in the text, and the results of field tests are given in appendixes.

MECHANICS. Two volumes: Part 1, Statics; Part 2, Dynamics. By J. L. Meriam. John Wiley and Sons, Inc., New York, N. Y., 1952. Bound, 6 × 9¼ in., 671 pp., diagrams, charts, $4 a volume. An engineering treatment of the subject designed to integrate the pre-engineering background of physics, mathematics, and graphics, and to equip the student with an effective approach to problem formulation as well as problem solution. The author progresses in easy stages from fundamentals to more advanced theory, with emphasis on the importance of principles. The introductory chapter on basic principles appears in both Part 1 on Statics and Part 2 on Dynamics. The appendixes containing moments of inertia and useful tables are likewise duplicated.

METAL DATA. Revised edition of Metals and Alloys Data Book. By Samuel L. Hoyt. Reinhold Publishing Corporation, New York, N. Y., 1952. Bound, 7¼ × 10¼ in., 526 pp., charts, tables, $10. This practical reference work contains in compact, usable form, carefully selected values for the physical and engineering properties of the metals and alloys of commercial importance and many of the less common ones as well. The wrought, cast, and stainless steels, cast irons, heat-resistant and corrosion-resistant casting alloys and nonferrous alloys are covered in detail. The revised edition contains much new material including data on the hardenability of H-steels and on new alloys such as the recently developed super alloys for high-temperature stress members. The data are mainly presented in tables, with brief comment.

MÉTALLURGIE. By R. Cazaud. Dunod, Paris, France, 65th edition, 1953. Bound, 4 × 6 in., 372 pp., charts, diagrams, tables, 450 fr. This condensed pocketbook of metallurgical information covers some thirty metals, chiefly those of the greatest commercial importance, giving briefly their properties, basic qualities, and metallurgical characteristics. Separate sections are devoted to metal corrosion, to heat-treatment methods, and to test methods for metals. Data tables and some common formulas are included at the back of the book.

NIEDERDRUCK-STROMRICHTERVENTILE. By Hans von Bertele. Springer-Verlag, Vienna, Austria, 1952. Bound, 6¼ × 9¼ in., 239 pp., charts, diagrams, illus., tables, $9.30. After a discussion of the physical phenomena involved, particularly in mercury-arc rectifiers, the characteristics of the individual structural types of low-pressure rectifiers are developed, with a simple graphical method for calculating output capacity and optimal operating conditions. Stress is laid on the influence and importance of the selection of materials and vacuum technology. The theoretical deductions are supported by practical examples. The detailed treatment includes the development from the beginning of the century to the most modern thyratrons, ignitrons, and excited single-anode rectifiers.

PHYSICAL METALLURGY FOR ENGINEERS. By Donald S. Clark and Wilbur R. Varney. D. Van Nostrand Company, Inc., New York, N. Y., 1952. Bound, 6½ × 9¼ in., 567 pp., tables, charts, graphs, illus., $6.50. This basic textbook for undergraduate engineering students is intended to be correlated with courses in design. Only the most elementary principles are included to give the student an understanding of the materials with which he will deal. Both ferrous and nonferrous metals are covered. Special properties, heat-treatment, corrosion, casting, mechanical working, and joining methods are dealt with as well as basic metallurgy. Questions are included at the end of each chapter to serve as a study aid.

PRACTICAL METALLURGY FOR ENGINEERS. E. F. Houghton and Company, Philadelphia, Pa., revised edition, 1952. Bound, 5¾ × 8¾ in., 599 pp., tables, illus., graphs, diagrams, $3.50. This practical reference and textbook gives detailed descriptions and explanations of a wide range of operations in the heat-treating and surface-hardening of metals and metal products. Introductory information on ores, fuels, refractories, temperature measurement, iron and steel manufacture, and so on, is provided. Allied topics such as cleaning procedures, steel classification, and metallography are also dealt with.

STANDARDS OF TUBULAR EXCHANGER MANUFACTURERS ASSOCIATION. Tubular Exchanger Manufacturers Association, Inc., New York, N. Y., third edition, 1952. Paper, 8¾ × 11¼ in., 150 pp., tables, charts, diagrams, $5.50. This publication contains recommended standards, consistent with safety and service requirements of the association, for the mechanical and thermal design and construction of cylindrical shell and bare-tube heat exchangers. The scope has been extended to conform with recent developments in materials, and so on, and a general information section has been added containing data useful to both the designer and user.

STATISTICAL THEORY IN RESEARCH. By R. L. Anderson and T. A. Bancroft. McGraw-Hill Book Company, Inc., New York, N. Y., first edition, 1952. Bound, 6¼ × 9¼ in., 399 pp., tables, charts, $7.50. This book was designed to serve as a reference work for research workers as well as an advanced textbook in the study of applied statistics. It is divided into two parts, the first of which presents basic statistical theory such as probability, population, and sampling theory, point and interval estimation, and the uses of the chi-square test. Part 2 covers analysis of experimental models by least squares. A knowledge of the calculus is required for effective understanding of the material. The text is well illustrated with actual experimental data and the necessary tables are appended.

STRUCTURAL ADHESIVES. Lectures given in Cambridge at the summer school held by Aero Research Limited, Duxford, September 23–29, 1951. Lange, Maxwell and Springer, Inc., New York, N. Y., 1952. Bound, 8 × 10 in., 203 pp., charts, diagrams, illus., tables, $4.20. Based on lectures on the technology of synthetic-resin adhesives given at Cambridge in 1951, this study is of practical value to many engineers, particularly those engaged in the aircraft and electrical industries. The specific applications are discussed in two sections: 1, Adhesives in the woodworking industries, covering gluing, glued joints, radio-frequency heating, etc.; 2, adhesives in the engineering, electrical manufacturing, and allied industries, covering metal bonding, bonding of ceramics, and so on. Introductory lectures discuss the chemical fundamentals of various adhesive

materials, the strength of glued joints, and other basic ideas.

STRUCTURE OF METALS. By Charles S. Barrett. McGraw-Hill Book Company, Inc., New York, N. Y., second edition, 1952. Bound, $6^1/_2 \times 9^1/_4$ in., 661 pp., tables, diagrams, charts, graphs, illus., $10. Both a text and reference on the atomic configuration of metals, this book covers the fundamentals of crystallography and the techniques of x-ray diffraction in its application to the determination of crystal structures, phase diagrams, preferred orientation, and stress measurements. The last half of the book contains the results of research on the structure of liquid metals, superlattices, the processes of slip, twinning, and fracture, x-ray studies of internal stress and other data. In this new edition extensive revision has been made concerning dislocations, imperfections, creep, the structures of solid and liquid metals and alloys, textures, and transformations. Appendixes of x-ray and crystallographic data are included.

STUDIES IN ELASTIC STRUCTURES. By A. J. S. Pippard. Longmans, Green and Company, Inc., New York, N. Y., 1952. Bound, $6^1/_4 \times 9^1/_4$ in., 361 pp., tables, graphs, diagrams, $11.50. This collection deals with studies applicable to a wide variety of designs. The stresses in circular rings, rotating wheels, frames, girders, pipe lines, and other structures are analyzed. The proofs are rigorous and a large number of examples are included to illustrate the practical approach to solutions of the problems. Although a knowledge of structural analysis is needed, the book will be useful both to students and practicing engineers.

SUPERCONDUCTIVITY. By D. Shoenberg. Cambridge University Press, New York, N. Y., second edition, 1952. Bound, $5^3/_4 \times 8^3/_4$ in., 256 pp., tables, charts, graphs, $6. The experimental and theoretical aspects of superconductivity are presented in this monograph. Magnetic, thermodynamic, and other thermal properties are discussed. This second revised edition gives a detailed account of the recent work on the structure of the intermediate state, on penetration effects, on phenomenological theories, and on the attempts at fundamental theories. Many experimental and numerical data are given. A bibliography is also included.

SYMPOSIUM ON INSULATING OILS. By Committee D-9 on Electrical Insulating Materials. American Society for Testing Materials, Philadelphia, Pa. (Special Technical Publication, No. 135), fourth series, 1952. Paper, 6 × 9 in., 37 pp., tables, charts, $1. This publication contains parts 2 and 3 of a series of articles on the evaluation of mineral transformer oil during service: Part 2, Correlation of oil characteristics with continued transformer operation; Part 3, An examination of selected transformers. These symposiums deal with studies on insulating oils being carried on in a number of laboratories.

THERMAL DIFFUSION IN GASES. (Cambridge Monographs on Physics.) By K. E. Grew and T. L. Ibbs. Cambridge University Press, New York, N. Y., 1952. Bound, $5^3/_4 \times 8^3/_4$ in., 143 pp., tables, charts, diagrams, $4.50. This monograph deals chiefly with experimental work although some theory is given. The application of thermal diffusion to the separation of gas mixtures and the related phenomenon called the diffusion thermo effect are also discussed. A brief account of thermal diffusion in liquids is included.

TIEFZIEHEN VON ALUMINIUM. By Mostafa Abdel Aziz. Verlag Leemann, Zürich, Switzerland, 1952. Paper, $6^1/_2 \times 9^1/_2$ in., 84 pp., 32 pp., charts, diagrams, illus., tables, 10 Sw. fr. This study of the deep drawing of aluminum was presented as a thesis to the Federal Technical Institute at Zürich. The author investigates the effect of lubricants and friction on the drawability of sheets, and the influences of various physical aspects are reviewed theoretically and tested experimentally. A formula is developed for calculating theoretical cup depth from other factors. Results of over 3000 tests are summarized graphically in an appendix.

VISCOSITÉ SOUS PRESSION RAPIDEMENT VARIABLE. By Fernand Charron. Paris, France. Ministère de l'Air., Publications Scientifiques et Techniques, no. 268, 1952. Paper, 7 × $10^6/_8$ in., 30 pp., tables, charts, diagrams, 550 fr. A description of the procedure and results of an investigation of the variability of viscosity of certain liquids—glycerine and lubricating oils—under rapidly changing pressures, within the range from 1 to 1000 atmospheres.

WAHL UND ENTWURF EINER GASTURBINE UND UNTERSUCHUNG IHRER EIGNUNG ZUM ANTRIEB EINES FRACHTSCHIFFES. By John J. McMullen. Verlag Leemann, Zürich, Switzerland, 1950. Paper, $6^3/_4 \times 9^1/_2$ in., 109 pp., charts, diagrams, tables, 13 fr. Covers the selection and design of a gas turbine, and an investigation of its suitability as a prime mover for a freighter. The author presents a theoretical comparison between open and closed cycles, with special attention to the design of a closed plant. Separate chapters are devoted to the arrangement of the machinery in the ship and to partial-load problems. Presented as a thesis to the Federal Technical Institute at Zürich.

WÖRTERBUCH DER SCHLEIF- UND POLIERTECHNIK. By B. Kleinschmidt. Technischer Verlag Herbert Cram, Berlin, Germany, 1952. Paper, $5^3/_4 \times 8^1/_4$ in., 96 pp., illus., 9.80 Dm. A specialized dictionary of grinding and polishing terms which contains in addition to the useful standard words the new, idiomatic, and variant terms which are not to be found in the usual technical dictionary. The book also includes a labeled, diagrammatic representation of a plain cylindrical grinding machine and photographic illustrations of a wide variety of specialized grinding machines. The captions are given in English as well as in German.

WOOD CHEMISTRY. (American Chemical Society Monograph Series.) Edited by Louis E. Wise and Edwin C. Jahn. Volume 2. John Wiley & Sons, Inc., New York, N. Y., second edition, 1952. Bound, $6^1/_4 \times 9^1/_4$ in., 652 pp., charts, diagrams, tables, $15. This second volume completes the new and expanded edition of a monograph describing the chemical behavior of wood and its components, and the fundamental chemistry involved in industrial processes. In this volume the surface properties of wood, its chemical utilization, its biological decomposition, and its chemical analysis are discussed. Some 2000 literature references are included as footnotes.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting January 23, 1953, and previously, and approved by the Board on March 11, 1953.)

CASE NO. 905-2 (REOPENED)

(*Special Ruling*)

Inquiry: Is it permissible to construct welded vessels for use in the range of −150 F to 650 F under the requirements of Section VIII of the Code using copper chromium nickel steel or copper chromium nickel cobalt steel of the following chemical compositions and physical properties?

	Grade A	Grade B
Carbon, max per cent	0.12	0.10
Manganese, per cent	0.55-0.85	0.35-0.55
Phosphorus, max per cent	0.04	0.04
Sulphur, max per cent	0.04	0.04
Chromium, per cent	0.65-0.85	0.65-0.85
Nickel, max per cent	0.75	0.75
Copper, per cent	0.45-0.65	0.45-0.65
Silicon, per cent	0.15-0.30	0.20-0.35
Cobalt, per cent		0.40-0.60
Tensile strength, psi	60,000-75,000	

All other requirements in accordance with Specification SA-212.

The specification test bars are to be normalized and stress-relieved at 1100 to 1200 F prior to test. The Charpy impact requirements will conform to Par. UG-84.

Reply: It is the opinion of the Committee that the material specified in this inquiry may be used in the range of

−150 F to 650 F under the requirements of Section VIII of the Code with the following additional provisions. (1) The impact-test requirements of Par. UG-84 shall be met. (2) The material shall be normalized before welding. (3) The maximum allowable stress value shall be 15,000 lb per sq in. (4) The completed vessel shall be stress-relieved. (5) All welded butt joints shall be fully radiographed.

CASE NO. 941–3 (REOPENED)

(Special Ruling)

Inquiry: Is it permissible to construct welded unfired pressure vessels in accordance with the requirements of Section VIII of the Code using high tensile manganese molybdenum steel conforming to ASTM Specification A-204-49T, modified as follows?

Carbon, max per cent	0.22
Manganese, max per cent	1.50
Phosphorus, max per cent	0.04
Sulphur, max per cent	0.04
Silicon, per cent	0.15-0.30
Molybdenum, per cent	0.40-0.70
Tensile strength, psi	90,000-105,000
Yield point, min psi	55,000
Elongation, min, in 2 in., per cent	2,300,000 / tens str

Reply: It is the opinion of the Committee that it is permissible to construct welded unfired pressure vessels of the steel specified in the inquiry under the requirements of Section VIII of the Code with the following additional provisions:

(1) The maximum thickness of shell or head shall be 2 1/2 in. Plate for shells or heads over 5/8 in. in thickness shall be normalized at 1650 F to 1700 F;

(2) The maximum allowable stress value shall be 22,500 psi;

(3) The service temperature shall not exceed 450 F;

(4) The material shall be preheated to as high a temperature as practicable and held there throughout the welding operation;

(5) Weld reinforcement shall be removed;

(6) After stress-relief the vessel shall be cooled slowly in the furnace to 600 F or below with the furnace doors closed;

(7) The completed vessel shall be stress-relieved;

(8) All welded butt joints shall be fully radiographed.

CASE NO. 989–2 (REOPENED)

(Special Ruling)

Inquiry: Is it permissible to use material conforming to ASTM Specification A-268, Grades TP 405, TP 410, and TP 430 in the construction of unfired pressure vessels in accordance with requirements of Section VIII of the Code?

Reply: It is the opinion of the Committee that it is permissible to construct unfired pressure vessels using the materials specified in the inquiry under the requirements of Section VIII of the Code. The allowable stress values and the special requirements for welding, stress-relieving, and radiographing shall be the same as for the corresponding grades of Specification SA-240.

CASE NO. 1056–4 (REOPENED)

(Special Ruling)

Inquiry: Is it permissible to construct welded unfired pressure vessels in accordance with the requirements of Section VIII of the Code using high-tensile manganese-steel conforming to Specification SA-299, modified as follows?

Carbon, max per cent	0.33
Manganese, per cent	0.85–1.15
Phosphorus, max per cent	0.04
Sulphur, max per cent	0.05
Silicon, max per cent	0.10

	Grade A 3/16 to 2/3 in.	Grade B Over 2/3 to 5/8 in.
Tensile strength, psi	75,000–90,000	73,000–88,000
Yield point, min psi	37,500	36,500
Elongation in 8 in. min per cent	1,600,000 / tens str	1,600,000 / tens str
Elongation in 2 in. min per cent	24.0	24.0

Reply: It is the opinion of the Committee that it is permissible to construct welded unfired pressure vessels of the steel specified in the inquiry under the requirements of Section VIII of the Code with the following additional provisions:

(1) The thickness of plate shall not exceed 0.58 inch;

(2) The maximum service temperature shall not exceed 650 F;

(3) The maximum allowable working stress shall be 18,750 psi for grade A and 18,250 psi for grade B;

(4) The requirements for welding in Section IX shall be the same as for Specification SA-299.

CASE NO. 1098–1 (REOPENED)

(Special Ruling)

Inquiry: Is it permissible to use tubes conforming to ASTM Specification A-270-50, Seamless and Welded Austenitic Stainless Steel Sanitary Tubing in the construction of pressure vessels under the requirements of Section VIII of the Code? This tubing is intended for use in the dairy and food industries where a superior type of finish is required such as is provided by this specification.

Reply: It is the opinion of the Committee that tubing made to ASTM Specification A-270-50 may be used in the construction of Code vessels intended for use in industries requiring the superior surface finish in this specification provided the following restrictions are met: The tubes shall not be rolled into tube holes or welded. The working pressure shall not exceed 250 psi internal pressure or 100 psi external. The service temperature shall not exceed 700 F.

CASE NO. 1118–1 (REOPENED)

(Special Ruling)

Inquiry: Is it permissible to use forgings conforming to Specification SA-350-52T in the construction of unfired pressure vessels under the requirements of Section VIII of the Code? The forgings are intended for use at low temperatures.

Reply: It is the opinion of the Committee that it is permissible to construct unfired pressure vessels of the material specified in the inquiry under the requirements of Section VIII of the Code with the following additional provisions:

(1) The service temperature shall not exceed 650 F;

(2) The allowable stress values shall be the same as for the corresponding grades of Specification SA-334;

(3) The requirements for welding in Section IX shall be the same as for the corresponding grades of Specification SA-334.

CASE NO. 1120–2 (REOPENED)

(Special Ruling)

Add the following as the last paragraph in the inquiry:

(3) 1 1/4 per cent chromium, 1/2 per cent molybdenum conforming to Specification SA-301, except that the chemical and physical requirements conform to Grade T-11 of Specification SA-213.

Delete the phrase "either of" in the fourth and fifth line of the first paragraph of the inquiry.

CASE NO. 1122-2 (REOPENED)

(Special Ruling)

Inquiry: May the extra low carbon grades of the austenitic stainless steels Types 304, 316, and 317 be used under the applicable Code rules pertaining to the regular grades of austenitic stainless steels?

Reply: It is the opinion of the Committee that the extra low carbon grades of Types 304, 316, and 317 may be used for construction under the Code rules applying to the regular grades of Types 304, 316, and 317 with the following modifications:

(1) The material shall conform to the requirement of an approved specification which covers the same grade with regular carbon content, except that:

(a) The carbon content shall be limited to 0.03 per cent max.

(b) The mechanical properties shall be as follows:

Tensile strength	70,000 psi min
Yield strength	25,000 psi min
Elongation in 2 in.	—as required by specification

(c) The stress values in tension (see table below) are to be used for vessels under internal pressure.

(2) The extra low carbon grade of austenitic steel Type 304 may be used for the construction of vessels under external pressure under the Code rules applying to the regular grade of Type 304 with the following modifications:

(a) The material shall conform to paragraphs (1) (a) and (b) above.

(b) The required thickness of shells and heads, and the required moment of inertia for stiffening rings, shall be determined from the chart in Fig. UHA-28.3.

Announcement

Since Section VI, "Rules for Inspection of Material and Steam Boilers" has been dropped from Section I, Code for Power Boilers, Forms P-5 and P-6, Manufacturers' Inspection Forms, which were a part of Section VI, are now printed with Form P-4A, Manufacturers' Data Report for Fabricated Piping, in Section I and are preceded by the following explanation on a separate page:

"Reports of Inspection of Installed Boilers" Form P-5 shall be used for reporting first internal inspection of boilers to the authorities in states or municipalities requiring complete data at the time of the first internal inspection. Form P-6 should be used for all subsequent inspections.

Cases Annuled

Case No.	*Reason for Annulment*
1002[1]	Revised Sect VIII, 1952 Edition
1094[2]	Case No. 934 now covers deoxidized copper material.

[1] Meeting of December 12, 1952.
[2] Meeting of January 23, 1953.

Alloy Material (L)	Spec Min Tensile	—20 to 100	200	300	400	500	600	650	700	750	800
Type 304 (T.S.)*	70000	17500	17000	16000	15000	14000	13000	12500	12000	11500	11000
Type 304 (Y.S.)	70000	17500	17000	13400	11000	9700	9000	8750	8500	8300	8100
Type 316 (T.S.)*	70000	17500	17500	15800	14750	14000	13600	13450	13250	13000	12700
Type 316 (Y.S.)	70000	17500	17500	14500	12000	11000	10150	9800	9450	9100	8800
Type 317 (T.S.)*	70000	17500	17500	15800	14750	14000	13600	13450	13250	13000	12700
Type 317 (Y.S.)	70000	17500	17500	14500	12000	11000	10150	9800	9450	9100	8800

* At temperatures from 200 F through 800 F these stress values meet all of the criteria specified for establishing stress values except that they exceed 62½ per cent but do not exceed 90 per cent of the yield strength at temperature. They may be used where slightly greater deformation is permissible.

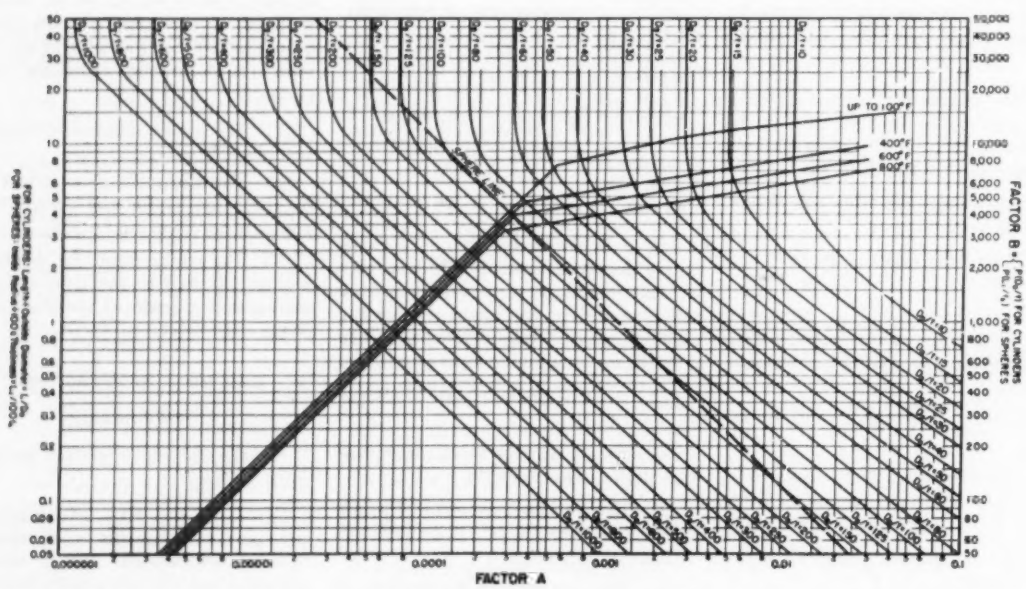

FIG. UHA-28.3 CHART FOR DETERMINING SHELL THICKNESS OF CYLINDRICAL AND SPHERICAL VESSELS UNDER EXTERNAL PRESSURE (WHEN CONSTRUCTED OF AUSTENITIC STEEL 18 CR-8 NI-0.003 MAX CARBON, TYPE 304 L)

ASME NEWS

With Notes on the Engineering Profession

ASME Tour Takes Scenic Route to the Coast for Semi-Annual Meeting in Los Angeles

National Parks Tour, June 12–28

THE preconvention tour planned for the members of The American Society of Mechanical Engineers en route to the 1953 Semi-Annual Meeting to be held at the Hotel Statler, Los Angeles, Calif., June 28–July 2, includes some of the most magnificent scenery both in the United States and Canada.

The tour leaves New York, N. Y., on Friday afternoon, June 12, via the New York Central Railroad for Chicago, Ill., and stops will be made along the way to take on passengers west of New York. Arrangements also can be made for members residing in areas served by other railroads to join the party at Chicago.

De Luxe Traveling Accommodations

This tour is arranged on a first-class travel basis with single- or double-bedroom pullman accommodations and choice rooms at the best hotels. The trip requires only ten days' absence from business, plus three week ends.

Few trips could be arranged that would include more scenic wonders or finer hotels and lodges.

If you were told you could make this trip for $400, provided you were planning to attend the Semi-Annual Meeting in Los Angeles, you undoubtedly would respond with alacrity. Well, you can do just about that. To attend the meeting would require at least twelve days for those traveling from the Atlantic Seaboard—seven days round-trip travel, plus time at the meeting. The tour lasts from June 12, from New York, to June 28, arriving at Los Angeles,—sixteen days in all. You would spend three and one-half days' travel going direct to the meeting so that extra time for the tour is twelve and a half days. This includes three week ends. The cost of the tour on all-expense basis—New York to Los Angeles—is about $750. That includes round-trip railroad ticket, but pullman bedroom one way only, and meals from New York to Los Angeles.

This is only about $400 more than you would pay for rail fare, pullman space, and meals if you went alone and direct. The round-trip rail fare is $220; the pullman bedroom, two in a room, $73.20; and six days' meals on the train, $50 approximately. This adds up to $343.20.

Where Will You Go?

First stop on the tour is at Lake Louise, one of nature's masterpieces, with a side trip through a region of glacier-fed lakes and streams, immense peaks, and to the Columbia Ice Field, a glacial vast sea of snow and ice which lies on the shoulders of the mountains forming the Continental Divide, then to Banff and Waterton Lakes Park, with a stopover at the Prince of Wales Hotel, which is a fine hotel "with a view." Then to Glacier Park and on down to Bryce Canyon, perhaps the most colorful place in nature's world, Zion Park, and the north rim of the Grand Canyon. All this for only $400 more than you would spend ordinarily.

It's a Friendly Trip

The fine companionship of your fellow ASME members and their wives is quite different from going alone or on a commercially conducted tour. Every detail is worked out for your comfort and enjoyment. In addition if you wish, suggestions will be made and arranged on your request for a pleasant and enjoyable trip over any route of your choice and including additional opportunity for sightseeing and so on.

For further information or advice please write Ernest Hartford at ASME Headquarters, 29 West 39th Street, New York 18, N. Y.

1953 WASHINGTON AWARD PRESENTED AT CHICAGO, ILL.

(Gustav Egloff, *left*, Mem. ASME, director of research, Universal Oil Products Company, Chicago, receives the 1953 Washington Award from O. W. Eshbach, president of the Western Society of Engineers, at a dinner meeting held on February 23. Ben. G. Elliott, vice-president ASME, Region VI, represented the Society at the dinner.)

ASME Boiler Code Committee to Meet in Oregon

THE second out-of-town meeting of the Boiler Code Committee of The American Society of Mechanical Engineers will be held jointly with the National Board of Boiler and Pressure Vessel Inspectors April 27–30, inclusive, at the Multnomah Hotel, Portland, Ore. The regular meeting of the Boiler Code Committee will be held, Thursday, April 30.

The meeting will include panel sessions on power boilers, unfired pressure vessels, and heating boilers. A banquet has been arranged for Tuesday evening and an inspection trip to Bonneville Dam is scheduled for Friday.

It is expected that lectures will be arranged at the various colleges and universities of the Northwest by members of the Boiler Code Committee.

The Boiler Code Committee holds seven meetings a year, one of which is held outside of New York, N. Y.

The President's Page

Should Engineering Become One of the "Learned Professions"?

ONE of the best ways in which our Society can contribute to a gradual raising of the standards of the engineering profession is through a continued and devoted interest in engineering education. The manner in which the horizons of the mechanical engineer have broadened in recent years is nothing less than frightening. Certainly it is sobering to consider that in most of our technical schools four years is still the allotted time in which a young man is expected to have achieved a grasp of the fundamentals of the engineering sciences.

Probably the vast majority of students, for financial or other reasons, would not find it easy to devote more than four years to their formal higher education, and I do not propose that those who wish to enter this profession should be barred from it, as, for example, the doctor or the lawyer is, through the lack of a graduate degree. I do suggest, however, that the basic engineering societies would do well to give the utmost consideration and encouragement to graduate study in the engineering fields, preceded preferably by an undergraduate course in which generous attention will have been given to the liberal arts and the humanities.

There was a time when the study of medicine and the law was confined to a four-year undergraduate course. Can anyone doubt that the standards of these professions were raised notably by the trend which led ultimately to the requirement of graduate study in their fields?

A number of our leading technical schools and universities are giving increased recognition to the rapid strides being made in the mechanic arts and sciences by the institution of optional five- and six-year courses and elevating the degree of ME, or its equivalent, to the graduate level. It is a trend worth watching and encouraging.

In the ideal case, engineering, too, should be one of the learned professions.

Frederick S. Blackall, jr., *President*
The American Society of Mechanical Engineers

1953 ASME Oil and Gas Power Division Meeting to Be Held in Milwaukee, Wis.

Schroeder Hotel Twenty-Fifth Conference Headquarters

THE Oil and Gas Power Division will celebrate its silver anniversary this year. Its twenty-fifth annual conference and exhibit will be held in the Schroeder Hotel, Milwaukee, Wis., May 25–28, 1953. Everyone interested in diesel, dual fuel, and gas engines should attend. The program, although incomplete, promises up-to-the-minute information on design, operating and maintenance developments, and an ample opportunity to meet old and new friends. Between technical sessions interest focuses on some forty-five to fifty exhibits of engines and accessories.

Some of the technical papers to be presented and discussed are as follows: "Valves for High-Output Engines," by Messrs. Allen and Newton of Thompson Products, Inc.; "A Photographic Study of Events in a 14-in., 2-cycle Gas Engine," by Ralph L. Boyer, Cooper-Bessemer Corp.; "Investigation of Flame Temperatures in Single-Cylinder Spark-Ignition Engines," by J. H. Potter and R. B. Dillaway, University of Illinois; "Two- and Four-Cycle Test Results of Medium-Speed Engines on Heavy Fuel," by Russell Pyle, D. C. Cryor, and J. M. A. Van der Horst, of Van der Horst Corporation of America; "Residual-Fuel Production and Utilization in Diesel Engines," by Messrs. Habermann, Albright, and Killingsworth, Socony Vacuum Company; "Packard Marine Diesel," by Marsden Ware, Packard Motor Car Company; "The Tuned Manifold on Supercharging Without a Blower," by H. W. Engelman, University of Wisconsin; and "Crankshaft Notes, With Particular Reference to Crankwebs, Including Arcweb Design," by S. W. Newell, Union Diesel Engine Company.

The theory and practice data to be presented during the technical sessions will be supplemented by inspection trips to several of Milwaukee's leading industries. The Milwaukee Section of the Society will act as host. A fine program is planned for the enjoyment of the women planning to visit in Milwaukee. Make your reservation early—mention the Oil and Gas Power twenty-fifth annual conference if you want to stay at the Schroeder Hotel during the meeting.

1953 OGP ORGANIZATION COMMITTEE HELD MEETING IN MILWAUKEE, WIS.

(Back row, *left to right*, Mrs. Robert Cramer, Jr.; Mrs. R. B. Adams; R. B. Adams; Robert Cramer, Jr., chairman; Robert Teece, co-chairman; Theodore Wetzel; and Warren Colwell, chairman, ASME Milwaukee Section. Front row, *left to right*, George Heberer, Robert Losse, Leo Brinson, and Harold Holler. Shown in the background are Schroeder Hotel style-show models.)

Second U. S. National Congress of Applied Mechanics Preliminary Plans Announced

THE second U. S. National Congress of Applied Mechanics will be held June 14–18, 1954, at the University of Michigan, Ann Arbor, Mich., under the sponsorship of the following: U. S. National Committee on Theoretical and Applied Mechanics, a joint committee of: American Institute of Chemical Engineers, American Society of Civil Engineers, The American Society of Mechanical Engineers, American Mathematical Society, American Physical Society, Institute of the Aeronautical Sciences, Society for Experimental Stress Analysis, the University of Michigan, and others to be announced.

The National Congresses, of which the first was held at Chicago, Ill., are held every four years between the International Congresses and are planned to supplement rather than compete with them. The next International Congress will be held at Brussels in 1956. No attempt will be made to attract participation by workers outside the United States and Canada in the National Congress, although there will be no rule against such participation.

All workers in the field are cordially invited to submit papers for the Second National Congress. Papers should constitute original research in applied mechanics, which includes kinematics, dynamics, vibrations, and waves; mechanical properties of materials and failure; stress analysis, elasticity, and plasticity; fluid mechanics; thermodynamics. Their length must not exceed 5000 words or the equivalent in equations, tables, and diagrams. It is intended that all papers accepted by the Editorial Committee, with the advice of recognized authorities in the respective field of interest, will be published in full in bound and printed Proceedings of the Congress. It is hoped that these Proceedings will appear within the year following the Congress.

To be considered for presentation at the Congress, complete papers and abstracts must be submitted to the chairman of the Editorial Committee, Paul M. Naghdi, Jun. ASME, Department of Engineering Mechanics, University of Michigan, before Jan. 1, 1954, and such presentation is subject to the full manuscript having been accepted prior to May 15, 1954. Consideration of a paper for publication in the Proceedings can be based only upon the full manuscript, and only papers actually presented at the Congress are eligible for publication.

The papers will be grouped by subject and one half hour will be allotted for presentation and discussion of each paper. Arrangements will also be made for general lectures by outstanding authorities on subjects of general interest to members of the Congress. Get-togethers will be provided for exchange of ideas and social contact.

Inquiries regarding the Congress should be addressed to the secretary of the Congress, Jesse Ormondroyd, Mem. ASME, Department of Engineering Mechanics, University of Michigan.

Western Computer Conference Held in Los Angeles, Calif.

IMPORTANT new developments in the electronic-computer field are emerging at an increasing rate, in many sections of the country. The impact of this program will pose a growing problem of scientific-manpower shortages, and some day this field of automatic intelligence may be the greatest single user of engineers and scientists. This is the picture that was painted at the Western Computer Conference, held at the Statler Hotel in Los Angeles on February 4 to 6.

The three-day conference was attended by over 700 electronic engineers and potential users of the new electronic computers. In addition to the technical sessions, more than 20 firms and organizations displayed latest developments in computer equipment.

Keynoting the conference were two addresses by Dr. Simon Ramo, vice-president of Hughes Aircraft Company, and Dr. R. D. Huntoon, chief of the Corona (Calif.) Laboratories of the National Bureau of Standards. Dr. Ramo pointed out that ultimately the universities

must turn out a new kind of doctor whose studies include the physical sciences, with emphasis on electronics, a study of the human brain (nature's example of a thinking machine), methods and procedures in business and industry, and government and labor rules and regulations. Even today, with the computer field in its infancy, the shortage of properly trained scientists and engineers is a bottleneck, he said.

Dr. Huntoon suggested that Darwin's theories apply to the evolution of "electronic brains" as well as to living ones; computing machines, in order to survive and prosper, must adapt to their environment. At the same time, he pointed out that users of these machines must be willing to think in terms of machine language.

In the technical sessions, a number of new developments and applications of computing equipment were described. A decimal computer capable of processing the weekly payroll for an organization of 4000 to 5000 employees, at the rate of 30 seconds per employee, was described. Another machine under development will sort, collate, select, and process more than 10,000 documents an hour, and process the information they contain, without regard to the size, shape, thickness, flatness, or degree of preservation of the documents being handled.

A look into the future of high-speed printing was presented, with a description of a magnetic reproducer and printer now under development. This machine will automatically record the subject matter (which may be the output of a computer) on a magnetically sensitive surface, after which the image would be developed by using a magnetic ink. This device promises to provide not only much higher printing speeds than present-day mechanical printers, but also can turn out any desired number of copies in the same manner as a newspaper printing press.

Another paper described the application of present-day computing equipment for the elimination of bottlenecks in the production of aircraft and similar industries. Diagrams were shown of such a system designed for a Los Angeles area firm, which would pay for itself in less than three years on clerical savings alone. The computing equipment would take over many of the routine paper-work jobs now being handled by clerks, but would leave the important decisions up to the production managers.

The computer exhibits were as progressive as the technical papers in presenting new advances in the computer field. Two organizations chose this conference for the unveiling of new analog computers. One of these was a compact electromechanical differential analyzer, useful in the solution of mathematical equations encountered in aircraft design. The other was a high-precision electronic analog computer, with an accuracy of 1/100 of 1 per cent.

Also exhibited was a model of a new, large-scale digital computer, this too unveiled for the first time at a computer convention. This machine was only recently released for public knowledge from its security cloaks, and is considered to be one of the largest and fastest machines of its kind.

ASEE Announces Preliminary Program for Annual Meeting

UNDERLYING theme of the 1953 annual meeting of the American Society for Engineering Education will be a broad evaluation of the job that the engineering colleges perform, according to Willis R. Woolrich, ASEE president, in announcing the preliminary program. This 5-day yearly convention will be held at the University of Florida, Gainesville, from June 22–26. It will comprise more than 100 conferences, general and divisional sessions, and luncheons and dinners.

The conferences will include a series on atomic-energy engineering; lectures on digital computers, sponsored by the society's mathematics division; and discussions by several leading industrial economists during the programs of the engineering-economy division. A major general session sponsored by the society's Engineering College Research Council will cover "The Encouragement of Fundamental Research as an Aid to Education in Engineering."

The technical-manpower situation as affected by ROTC policies and Selective Service calls will be reported by the society's manpower committee to the Engineering College Administrative Council.

Leaders in technological education from all countries outside the Iron Curtain have been invited by the Administrative Council's international-relations committee to attend the annual meeting.

General chairman of the arrangements committees appointed by the host institution is John C. Reed, Mem. ASME, head of mechanical engineering at the University of Florida.

The annual meeting, the society's sixty-first, will be preceded by an intensive three-day summer school held by the industrial-engineering division. This will begin Saturday, June 20.

The educational-methods division and the General Electric Company will jointly hold a summer school at Schenectady, on dates yet to be set but preceding the Gainesville meeting. Stress will be laid on the teaching techniques used in G.E.'s advanced-engineering course.

The ASEE was founded in 1893 as the Society for the Promotion of Engineering Education. It has nearly 200 institutional members, including every accredited engineering college in the United States, and more than 7200 individual members from engineering and scientific institutions and from industry.

Dates for the second international conference on engineering education to be held in Europe will be September 27–October 2, 1954, if recommendations recently passed at the first conference are accepted, reports Dean Willis R. Woolrich of the University of Texas. The recommendations go to "EUSEC"—the International Committee on Engineering Education of the United States and the European Council of Engineering Societies.

Reinforced Plastics Conference Reviews Annual Advancement

OVER 700 persons registered in advance for the Reinforced Plastics Division Conference of The Society of the Plastics Industry, Inc., held Feb. 18–20 in Washington, D. C., at the Shoreham Hotel. This eighth annual technical and management conference attracted the largest attendance in the history of this new branch of the plastics field.

For the first time these three-day sessions covered the management as well as the technical side of the reinforced-plastics industry. This broadening of the conference program has been brought about by the expansion taking place in the approximately 120 companies in this industry.

Subjects discussed on Wednesday, February 18, included standards, molding processes, finishes, fillers, and a panel on reinforced-plastics products, case histories of mass-produced automobile bodies, electrical insulating components, accounting-machine parts, refrigerator liners, and luggage.

On Thursday, February 19, there was a forum in which military and government-agency personnel, representing all branches of the Armed Forces, discussed the use of reinforced plastics in transportation equipment, aircraft, communications, and the like. In the afternoon a forum of plastic raw-material manufacturers told of the latest developments in plastic resins.

New developments in fibrous reinforcements was the feature at one of the forums on Friday morning, February 20. Another forum on equipment, presses and molds, covered preform molding equipment, matched tooling, development tooling, and so forth. In addition, at a session on management problems, talks were given on proprietary-item sales, custom-molding sales, military-item sales as well as development-contract sales.

In the afternoon those in attendance had the opportunity to present questions to a panel made up of speakers of the three-day sessions at a technical and management forum, followed by a talk on the development of fabrication techniques for high-temperature resistant structural components.

A special exhibit of reinforced-plastics products emphasized those now manufactured for the military, and civilian products which could be used for military applications.

Approximately 19 million lb of polyester resins for reinforced-plastics products were sold in 1952. This compares with approximately 14 million lb in the previous year. The fibrous glass used as the reinforcing agent with polyester plastic amounted to approximately 11 million lb last year.

Prospects for this year indicate a probable market for a 40 per cent increase to the 27 million lb figure for polyester plastics for reinforced products. Because of recent improvements in techniques it is likely that the proportion of glass fibers which are used with this plastic will increase and that well over 16 million lb of fibrous glass will be involved within the year.

Cornell Gifts Complete the Cost of Two Engineering Laboratories

ATTAINMENT of the over-all objective of $1,762,000 to cover the cost of Kimball and Thurston Halls, the new engineering laboratories at Cornell University, was recently announced by the University.

Willard I. Emerson, vice-president for university development, reported gifts totaling $1,188,832 from 141 alumni and other individuals, $295,000 from 30 corporations, and $142,000 from foundations. Accumulated interest amounted to $136,168.

Almost $1 million of the funds came from gifts to the Cornell Engineering Development Fund between 1942 and 1950. The remainder was raised by a committee under the chairmanship of Walker L. Cisler, Fellow ASME, Cornell alumni trustee and president of the Detroit (Mich.) Edison Company. The group worked closely with S. C. Hollister, Mem. ASME, dean of the college of engineering.

The new engineering center bears the names of two leaders in Cornell engineering. The materials-testing laboratory, Thurston Hall, honors Robert H. Thurston, who was director of Sibley College of Mechanical Engineering at Cornell from 1885 until his death in 1903. The other unit, a material-processing laboratory, is named for the late Dexter S. Kimball, first dean of the College of Engineering.

Thurston Hall contains special facilities for work in problems of stress and the testing of engineering materials and structures. Kimball Hall houses machine shops and equipment for teaching and research in tool design, plant layout and organization, production techniques, and time-and-motion study.

Construction of the units began in March, 1951. Thurston Hall is already in operation, with more than 1100 students using its facilities. Kimball Hall is complete except in minor details.

People

A. A. Potter, past-president and Hon. Mem. ASME, dean of the school of engineering, Purdue University, will retire from his duties on June 30, 1953, and will be succeeded by George A. Hawkins, Mem. ASME, professor of thermodynamics and associate director of the Engineering Experiment Station.

* * *

Gustav Egloff, Mem. ASME, director of research, Universal Oil Products Company, Chicago, Ill., received the Washington Award for 1953, at a dinner meeting of The Western Society of Engineers held in Chicago, Ill., Feb. 23, 1953. Ben G. Elliott, vice-president ASME, Region VI, represented the Society at the dinner.

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J. Calvin Brown, past-president and Fellow ASME, represented the Society at the inauguration of Raymond B. Allen as chancellor of the University of California, Los Angeles Campus, on March 20.

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Warren H. McBryde, past-president and Fellow ASME, represented the Society at the inauguration of Clark Kerr as chancellor of the University of California, Berkeley Campus, March 23.

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Clarence C. Franck and James A. Quaid, Members of ASME, will represent the Society at the fifty-seventh annual meeting of the American Academy of Political and Social Science to be held at the Benjamin Franklin Hotel, Philadelphia, Pa., April 10–11, 1953.

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J. W. Struve, president, Rich Manufacturing Company, Los Angeles, Calif., was elected president of the Cast Iron Soil Pipe Institute for 1953.

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Paul W. Kiefer, Fellow ASME, recently retired as chief engineer of equipment for the New York Central System after 48 years' service. He has received numerous awards for his work, including the ASME Medal, 1947.

* * *

ASME Membership as of Feb. 27, 1953

Honorary Members	52
Fellows	380
Members	13,642
Associates	351
Juniors (33 and over)	3,125
Juniors (30–32)	1,858
Juniors (to the age of 29)	19,024
Total	38,432

CD Plant-Protection Awards Inaugurated

THE New York State Civil Defense Commission inaugurated the first of a series of Plant Protection awards for outstanding planning and training for the protection of personnel and equipment.

Lieut. Gen. C. R. Huebner, director of the Commission, said that each award will consist of a banner and a citation of award. The banner, first of its kind in the State and designed to be flown like the famous Army-Navy "E" pennant of World War II, will be presented to certain up and down-state plants. The initial presentation was made March 5 to the International Business Machines Corporation, at Endicott, N. Y.

Other Plant Protection awards were presented to the following: Lederle Laboratories at Pearl River, N. Y.; simultaneously to the New York Telephone Company, Consolidated Edison Company, and the New York Dock Company; and Scintilla Magneto Division, Bendix Aviation Corporation, Sidney, N. Y.

General Huebner urged all plants in the State to qualify for the award by enrolling and training CD workers in a plant-protection program and to have other workers volunteer for CD services in their local communities. He explained that the "adequacy of plant protection measures includes the organization and planning for the protection of the employees and the establishment, including essential machinery and equipment; training of personnel in their assigned responsibilities; provision for warning devices and physical shelter accommodations; and availability of essential emergency supplies and equipment.

The new banner to be flown at industrial plants is a white flag with large red letters stating "Awarded for Plant Protection" and has the familiar CD insignia in the center. The citation that accompanies each flag is suitable for framing and reads, in part, as follows: "In honorable recognition of outstanding organization, planning, and training for the protection of plant personnel and equipment and for rendering patriotic co-operation in the establishment and promotion of Civil Defense in the State of New York."

Engineers Must Have Broader Training

THE world can truly say to the engineer, "You made me what I am today," according to Philip Sporn, Fellow ASME, utilities executive, told graduates of Illinois Institute of Technology at Commencement exercises which were held in the Museum of Science and Industry.

Mr. Sporn, who is president of the American Gas and Electric Company, one of the largest utilities companies in the United States, declared that the engineer can be justly proud of his work.

"Any part of the world is within a relatively few hours' reach of the rest of the world and therefore capable of affecting or being affected by it," Mr. Sporn said.

"This contraction in space—spatial integration—was made possible by the airplane and the telephone. But, while the world has been integrated spatially, no such integration has taken place politically, economically, or spiritually.

"If it had, our troubles would be over.

"Since the morass in which mankind finds itself today is tied up with technological development, with its remarkable growth as contrasted with the limited progress in the social sciences, the question arises: should there be a moratorium on scientific and engineering development until our social development catches up?" Mr. Sporn asked.

"My answer is: the world of tomorrow we are seeking will never come into being without more engineering and more engineers.

"The economic condition of great masses of the human race is so bad, their daily life is so miserable, that we must first improve their material well-being before we try to kindle faith and hope in our system of freedom in their hearts.

"That means the use of more tools and power, the development of greater skills—in short, more and better technology.

"We need technological integration as a base for economic integration, and as a prelude for spiritual integration. The political integration will come in due course but much more slowly."

According to Mr. Sporn, the engineer will have to become a member of a much broader group—lawyers, medical people, economists, sociologists, legislators, public officials, and administrators—all architects of social progress.

"This will require some changes in the engineer's basic training," he declared. "The engineer should be educated in the basic sciences, the humanities, and the social sciences, and thoroughly grounded in engineering fundamentals and principles.

"Only after we have succeeded in establishing a satisfactory broad training will we have the better-rounded engineers the future demands," Mr. Sporn concluded.

During the Commencement exercises, an honorary doctor of engineering degree was conferred on Mr. Sporn for his "distinguished leadership in the field of power-systems engineering."

Engineers and Their Achievements Theme of Engineer's Week TV Program

ONE of the high lights of Engineers Week celebrated from Feb. 22 to 28, 1953, was a half-hour television program which was broadcast from Washington, D. C., from 10:30 to 11:00 p.m. over Station WTTG of the Dumont (WABD Channel 5) television network. The program was sponsored by the New York Chapter of the National Society of Professional Engineers through the efforts of F. D. Cardwell, Mem. ASME, and chairman of the Program Committee, who was assisted by H. F. Roemmele, Mem. ASME, and president of the New York chapter, and Frank Billhimer, past-president of the chapter.

The principal speaker was George W. Malone, U. S. Senator from Nevada and a professional engineer, who spoke on the need for professional engineers in public office since many of the public problems of today are of a highly technical nature. Thomas T. Goldsmith, Jr., director of research of the Dumont Laboratories, spoke on the achievements of engineers in the field of communication and electronics. Dean Roemmele discussed the qualifications of a professional engineer from the educational and engineering-experience standpoint. Mr. Billhimer told about the new method of transportation of huge automobile trailers on flat-cars which relieved the public highways for public use.

Many still pictures and movies were shown of great engineering achievements, including the New York City skyline, housing projects, chemical plants, new developments in rail transportation, and the atom-bomb burst, with emphasis on the engineering know-how that enabled the free world to emerge triumphant from World War II. The pictures were accompanied by a running commentary by the moderator, Matthew Warren of Dumont. The script was prepared by Howard Merrill, and the program was directed by Lee Polk, both of Dumont.

The program was a huge success and tribute to the professional engineers of America, whose primary function is to safeguard the life, health, and safety of the public.

A ceremony honoring James Buchanan Eads, pioneer American engineer, was held Feb. 24 at the New York University Hall of Fame on University Heights, as part of the observance of Engineers' Week. Captain Eads, who died in 1887 and was nominated to the Hall of Fame in 1920, designed and built the bridge across the Mississippi River at St. Louis. A wreath was placed at the bust of Captain Eads, the first engineer elected to the Hall of Fame. The ceremony was under the sponsorship of the Metropolitan Joint Committee for Engineers' Week.

Helicopters Proved in War —Enter New Field in Peace

THE helicopter, described by the chief of Army transportation as the greatest advance in transportation equipment since the steam engine, is proving itself a lifesaving vehicle of the first magnitude in the Korean War. In Korea 70 of the Army's "whirlybirds" have rescued well over 12,000 wounded enabling the survival of at least 89 per cent of helicopter-evacuated wounded, according to an internationally-known pioneer in rotary wing aircraft development.

"Use of the helicopter as an aerial truck will make our Army a highly mobile striking force of high military potential," said James Allan Jamison Bennett, assistant to the chief engineer, Hiller Helicopters, Palo Alto, Calif., when he addressed the Southern California Section of The American Society of Mechanical Engineers at their monthly dinner meeting on February 12.

The Army uses helicopters primarily for evacuations, reconnaisance, air freight, and taxi service as well as for a number of other equally urgent assignments. As a civil transport, Dr. Bennett declared, operational experience on scheduled services with the helicopter has been acquired by two operating companies in the United States and two in Europe. Los Angeles Airways is in the lead with some 24,000 flying hours carrying mail in the greater Los Angeles area. Helicopter Air Services has flown 16,000 hours in the Chicago area, carrying mail since 1943. Now New York Airways is about to start mail services in the New York area, linking New York's airports with Manhattan. New York Airways plans to fly passenger services after initial experience with mail.

Dr. Bennett is a native of Scotland, educated at the Universities of Glasgow, London, and Gottingen. He holds doctor's degrees in both science and philosophy. He is a fellow of the Royal Aeronautical Society, and a founder-member of the Helicopter Association of Great Britain. He is the author of many papers.

Index Method of Testing

Supplement to ASME Power Test Code for Hydraulic Prime Movers

SEVERAL years ago the recommendation was made to the ASME Power Test Code Committee No. 18 that consideration be given to the preparation of a supplement to the Test Code for Hydraulic Prime Movers. This addition to the code was to cover index testing for adjustable-vane propeller-type runners or for use in maintaining efficient operation of reaction or impulse turbines. A subcommittee was appoined to undertake this project. It is now possible to announce the completion, approval, and publication of the supplement on the Index Method of Testing. Copies of this method may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y., upon the remittance of 25 cents for each copy.

Meetings of Other Societies

April 20–23
Society of Automotive Engineers, national aeronautics meeting and aircraft engineering display, Governor Clinton and Statler Hotels, New York, N. Y.

April 24–25
Society for the Advancement of Management, seventh annual time-study and management conference, Statler Hotel, New York, N. Y.

April 26–29
American Institute of Chemical Engineers, Chemical Institute of Canada, joint meeting, Royal York Hotel, Toronto, Ont., Can.

April 27–May 1
Society of Motion Picture and Television Engineers, 73rd convention, Hotel Statler, Los Angeles, Calif.

April 29–May 1
Natural Gasoline Association of America, 32nd annual meeting, Rice Hotel, Houston, Texas

May 6–8
American Society of Training Directors, ninth annual conference, Sheraton Plaza Hotel, Boston, Mass.

May 7–8
The Society of Naval Architects and Marine Engineers, spring meeting, Statler Hotel, Boston, Mass.

May 9–15
Society of the Plastics Industry, annual meeting and conference, cruise to Bermuda

May 10–15
American Water Works Association, 73rd annual conference, Grand Rapids, Mich.

May 11–15
National Fire Protection Association, annual meeting, Edgewater Beach Hotel, Chicago, Ill.

May 14–23
International Petroleum Exposition, Tulsa, Okla.

May 18–19
Association of Iron and Steel Engineers, spring conference, Statler Hotel, Buffalo, N. Y.

May 18–22
Materials Handling Exposition, fifth national show, Convention Hall, Philadelphia, Pa.

May 20–22
Engineering Institute of Canada, annual meeting, Nova Scotian Hotel, Halifax, N. S., Can.

May 21–23
Society for Experimental Stress Analysis, spring meeting, Hotel Schroeder, Milwaukee, Wis.

(*ASME Calendar of Coming Events, see page 350*)

Fifty Years That Changed the World

LIEUTENANT General James H. Doolittle, winner of the Wright Memorial Trophy and National Chairman of the Committee to Observe the 50th Anniversary of Powered Flight, told a Wright Anniversary dinner audience that, "This country must adopt, at the earliest possible date, a long-range consistent air-power policy and a realistic military aircraft development and production program."

He declared: "In the face of aggressive communism, we must have our air power preeminent. We cannot afford to gamble, as we have in the past, that we will have time in an emergency to build up our air forces." General Doolittle added that a long-range program "is the best security buy we can get with our tax dollar."

The famous flyer and aviation scientist spoke at the Wright Memorial Dinner, sponsored annually by the Aero Club of Washington, launching a year-long celebration throughout the nation to commemorate the first heavier-than-air flight by the Wright Brothers at Kitty Hawk, N. C., on Dec. 17, 1903.

Three outstanding trophies were presented at the dinner for contribution to the advancement of aviation. The recipient of the Collier Trophy was John Stack, assistant director of the Langley Aeronautical Laboratory of the National Advisory Committee for Aeronautics. General Doolittle received the Wright Memorial Trophy. Major General Lucas V. Beau accepted the Brewer Trophy on behalf of the Civil Air Patrol, of which he is National Commander.

Turning to the field of education, General Doolittle called for a "broad and comprehensive program to develop career interest among American youth in the whole field of aviation, including technology, operations, and the armed forces." He said that an education program should start in kindergarten, continue through college, and include widened opportunity for scholarships for capable students.

He emphasized the need for public understanding and support of both the educational and long-range procurement and production programs.

Describing the story of aviation as the "most momentous 50-year period in modern history," General Doolittle outlined the benefits that aviation has given to mankind.

"The airplane has opened up backward areas. Many countries once isolated by terrain or travel time have been brought within easy visiting range of the rest of the world . . . Today every part of the world can be readily reached by airplane or helicopter . . .

"The airplane has been a great boon to mankind in drawing all the people of the world closer together and leading to better understanding . . . The airplane has brought knowledge where it did not exist before. It performs stirring missions of mercy. We must exploit to the utmost the advantages which this great social tool provides."

General Doolittle paid tribute to the pioneers of aviation and foresaw a future "as limitless as the space surrounding this planet of ours."

Tracing the history of aviation, he recalled that in 1903 the aircraft industry in the United States "consisted, you might say, of a Dayton bicycle shop which employed two men, Orville and Wilbur Wright. Today, aircraft manufacturing has become our second largest industry. During the second World War, it was the largest.

General Doolittle then described the remarkable growth of the airplane as a commercial and private transportation vehicle. He recounted that the first flight carried one man aloft for 12 seconds. This year, he added, the scheduled airlines of the United States will carry an estimated 28½ million passengers a distance of 15 and ½ billion miles. And he pointed out that American business firms alone own an estimated 9500 planes, of which some 1700 are multiengined.

"That first engine back in 1903 developed about 16 hp and sustained a flight of only a few seconds," said General Doolittle. "The modern jet engine of today develops the equivalent of over 10,000 hp, and one U. S. manufacturer reports that, to date, his jet engines alone have logged more than 600 million miles."

With regard to the anniversary committee he heads, General Doolittle said he was glad to be a part of a national effort to further acquaint the American people "with the great advantages which aviation offers our nation." He added that the committee's plan is to sponsor a series of aviation events throughout 1953, climaxing in a "rousing celebration" of the airplane's 50th birthday on Dec. 17, 1953. He reported that government agencies, civic organizations, and many eminent citizens have offered their wholehearted support.

Milan's National Museum of Science and Technics Opened

THE new National Museum of Science and Technics was opened in Milan, Italy, at the beginning of February, 1953, with a magnificent Exhibition on the Science and Technique of Leonardo da Vinci, in celebration of the fifth centenary of his birth.

The Italian Technical and Scientific Press Association has set up a Centre of Consultation for the Technical and Scientific Press in the Museum. The purpose of this Centre is to bring the greatest possible number of technical reviews from all over the world to the attention of scholars throughout Italy.

The Centre is not only a library of periodicals; it also provides an information service and a link between publishers of technical reviews and authors of technical and scientific articles, and between publishers and scholars. The Association has organized and will organize exhibitions of scientific and technical periodicals on occasions of national importance in the industrial, technical, and scientific fields; such as the Milan Fair and the Turin International Technics Exhibition.

Vienna to Be Site of 1953 ICC Conference

FURTHER details regarding the international business economic conference in Vienna, Austria, were released by the United States Council of the International Chamber of Commerce. The meeting—the regular biennial Congress of the International Chamber—will be held from May 18 through May 23. Some 1000 businessmen from 50 countries have indicated that they will go to Vienna.

The Congress of the International Chamber is the general assembly of the world business community, the final authority of the International Chamber, which analyzes, determines, and proposes to governments, legislatures, and public opinion general policies in the field of international economics. It meets every two years and is attended by a most representative group of business executives from all over the free world, from Europe, from Latin America, from Asia, from Africa, and from Australia. Also attracted to the Congress are top-government representatives who seek the advice of world business on vital economic issues of the day.

The 1953 Congress of the International Chamber of Commerce will be especially important because of the present complex and trying world situation where people everywhere are going through a process of re-examination of policy. Once the statesmen of the various countries have concluded their projected trips to Washington, it can be expected that some of the policies agreed upon will be "tried out" and debated as to their ultimate success at the ICC conference in Vienna. The theme of the Vienna meeting will be "World Trade Is Everybody's Business."

Every day, Monday through Saturday, the week of May 18, there will be committee meetings in the morning and in the afternoon. Seventeen committee meetings, five general meetings, and two plenary sessions are scheduled for the Congress week. There will be thirty hours of open debate, in addition to the closed meetings, the private meetings, and the individual get-acquainted sessions.

These meetings will cover nearly all the vital subjects facing the free nations in the international economic field at this time. Among the many topics that will be under discussion during the six days of Congress activity are the following: Better international protection of industrial property, effective world protection of patents, increasing productivity for trade expansion, economic stability and raw-material production, international stock-piling policy, modern techniques for lowering distribution costs, international protection of trademarks, and technological progress versus economic nationalism.

Coming Meetings

Lubrication Engineering

LUBRICATION engineering and increased plant efficiency is the theme of the eighth annual meeting of the American Society of

Lubrication Engineers to be held April 13-15, 1953, at the Hotel Statler, Boston, Mass.

The program includes some of the following topics for discussion: "What Lubrication Means to the Builder of Machine Tools," "Textile Machinery Lubrication From Management's Point of View," and "Practical Application of Laboratory Test Data."

Special subjects of great interest to plant operations will be covered in two symposiums, one on "Diagnosing Failures in Rolling Contact Bearings," and the other on "Recognizing Sleeve-Bearing Troubles."

The education of plant maintenance personnel will come into focus in the forum, "The Training of Hydraulic Journeymen." This forum is of tremendous importance because of the greatly increased use of hydraulics in controlling machine operations and its vital position in the trend of industry toward automation.

The society is also sponsoring its annual lubrication exhibit in the ballroom of the Hotel Statler.

Hard-to-Machine Materials

A PANEL discussion on "Hard-to-Machine Materials," reports of special research on grinding of geometric sections, and a tour of the new million-dollar machine-tool laboratory of Purdue University at Lafayette, Ind., will feature the Tool Engineering Conference at Purdue on April 18.

H. L. Newport, instructor in manufacturing processes at Purdue, will report on results of his special research in "Grinding of Geometric Sections" at the 10 a.m. session of the meeting. He will discuss methods and machines for producing externally ground shapes of other than circular cross sections, such as squares, ovals, triangles, and elipses. He will also discuss the application of such shapes to product design.

The afternoon session will be a panel discussion on "Machining Hard-To-Machine Materials." Processes to be discussed by the panel will include electromechanical (arc) machining, electrolytic grinding, ultrasonic machining, and electrospark machining.

Air Conditioning

EIGHT national organizations will join Lehigh University's department of mechanical engineering in sponsoring a two-day conference on trends in year-round residential air conditioning. The sessions will be held April 24 and 25 in Packard Auditorium on the Lehigh University campus.

The purpose of the conference is to explore areas in which research in air conditioning is now in progress or fields in which research and development are needed.

Subjects to be discussed include trends in modern housing, reports on current research, residential load calculation, operating cycles and equipment design, vapor problems, and university and research-laboratory programs.

Organizations co-operating in sponsorship of this conference with Lehigh University are: American Society of Heating and Ventilating Engineers, American Society of Refrigerating Engineers, The American Society of Mechanical Engineers, Air Conditioning and Refrigeration Machinery Association, National Association of Home Builders, Building Research Board, National Mineral Wool Association, National Warm Air Heating and Air Conditioning Association.

Brussels International Fair

THE 27th Brussels International Fair will be held April 25-May 10, 1953, in The Great Centenary Halls.

Among the 30 industrial groups of new machinery to be shown at the exhibition are machine tools, welding apparatus, woodworking machinery, accessories and equipment for machine tools, motors, compressors, pumps, firefighting plants, spray-painting apparatus, handling and weighing appliances, mechanical and metal machines and construction, metals and foundry work, testing and measuring appliances, laundry machinery and plant, machinery for leatherworking, and machinery for papermaking, printing, drawing materials, and accessories.

Liege International Fair

THE fifth Liege International Fair will be held from April 25 to May 10, 1953, in the Coronmeuse district to the north of town and on the left bank of the Meuse.

The exhibition will include standard products and the latest equipment applicable in the fields of mining, metallurgy, mechanical engineering, and industrial electricity. In the specialized exhibits will be shown methods of coal mining by mechanical means and by explosives, equipment and products of iron-smelting industries, power engines, and the applications of electronics in industry.

Thermodynamics

RECENT developments in thermodynamics will be considered at the First Iowa Thermodynamics Symposium to be held April 27-28, 1953, at the State University of Iowa at Iowa City. The symposium will deal in particular with processes involving heat and mass transfer. Applications of the topics to be discussed will be found in the fields of jet engines and many other phases of gas dynamics. The symposium is designed for persons in the academic field and in industrial research engaged in advanced thermodynamics.

For further information write to Dean Francis M. Dawson, College of Engineering, State University of Iowa, Iowa City, Iowa.

British Fair

THE section designated "Engineering" will be the largest at the British Industries Fair this spring. Nearly 500 firms will be showing their recent developments at Castle Bromwich, Birmingham, England, between April 27 and May 8.

The B.I.F., the largest industrial fair in the world, will have many other sections to interest overseas buyers. Altogether some 2500 manufacturers in nearly 100 different trades will be exhibiting their latest products in three centers, two in London and one in Birmingham. Heavy industry and hardware again appear at Castle Bromwich, Birmingham, while consumer goods will be shown at Olympia Hall and Earls Court, London.

ASME Calendar of Coming Events

April 12-15
ASME Region VIII, Annual Regional Meeting, Jung Hotel, New Orleans, La.

April 15-16
ASME Management Conference, Rackham Memorial Building, Detroit, Mich.
(Final date for submitting papers was Dec. 1, 1952)

April 27-30
ASME Boiler Code Committee out-of-town meeting, Multnomah Hotel, Portland, Ore.

April 28-30
ASME Spring Meeting, Deshler-Wallick Hotel Columbus, Ohio
(Final date for submitting papers was Dec. 1, 1952)

May 24-28
ASME Oil and Gas Power Division Conference, Hotel Schroeder, Milwaukee, Wis.
(Final date for submitting papers was Jan. 1, 1953)

June 18-20
ASME Applied Mechanics Conference, University of Minnesota, Minneapolis, Minn.
(Final date for submitting papers was Feb 1, 1953)

June 28-July 2
ASME Semi-Annual Meeting, Hotel Statler, Los Angeles, Calif.
(Final date for submitting papers was Feb. 1, 1953)

Sept. 21-25
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Sherman Hotel, Chicago, Ill.
(Final date for submitting papers—May 1, 1953)

Sept. 28-30
ASME Petroleum Mechanical-Engineering Conference, Rice Hotel, Houston, Texas
(Final date for submitting papers—May 1, 1953)

Oct. 5-7
ASME Fall Meeting, Hotel Sheraton, Rochester, N. Y.
(Final date for submitting papers—June 1, 1953)

Oct. 29-30
ASME Fuels Division and AIME Coal Division Joint Conference, Conrad Hilton Hotel, Chicago, Ill.
(Final date for submitting papers—June 1, 1953)

Nov. 29-Dec. 4
ASME Annual Meeting, Statler Hotel, New York, N. Y.
(Final date for submitting papers—July 1, 1953)
(For Meetings of Other Societies, see page 348)

Electronic Components

SIX general sessions have been scheduled for the 1953 Electronic Components Symposium to be held April 29-May 1 at the Shakespear Club in Pasadena, Calif.

The subject to be covered will be "Critical Problems Being Faced by the Electronic Industry in Meeting Industrial and Military Demands." Six papers will be presented on subjects relating to the session topic "Environmental and Packaging Problems."

"Electronic Tubes and Tube Reliability" will be the topic of the morning session of April 30, and the afternoon session will take up the "Reliability Problems."

The morning session, May 1, which will cover "Resistors, Capacitors, and Dielectrics," will be followed by the closing session on "New Devices and Materials."

Education

Endeavour Prizes

AS A contribution to the meeting of the British Association for the Advancement of Science to be held in Liverpool, England, on Sept. 2–9, 1953, Imperial Chemical Industries Limited, publishers of the quarterly scientific review *Endeavour*, have offered the sum of 100 guineas to be awarded as prizes for essays submitted on a scientific subject. As the primary purpose of these awards is to stimulate younger scientists to take an interest in the work of the British Association and to raise the literary standard of scientific writing, the competition is restricted to those whose twenty-fifth birthday falls on or after June 1, 1953.

Five prizes will be awarded: first prize, 50 guineas; second prize, 25 guineas; third prize, 15 guineas; and two special prizes of 5 guineas for competitors who have not passed their eighteenth birthday on June 1, 1953.

The subjects for the essays are as follows: radio-astronomy, color and chemistry, biology in world affairs, science and safety in transport, science and art, scientific contributions to medicine, scientific societies and their role, and power and civilization.

The essays, which must be in English and typewritten, should not exceed 4000 words in length, and only one entry is permitted from each competitor. All entries should be addressed to: The Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1, England, and the envelope should be clearly marked "*Endeavour* Prize Essay." The latest date for receipt of entries is June 1, 1953.

The essays should be submitted without signature. The competitor's full name and address and date of birth should be disclosed in a sealed covering letter attached to the essay and addressed to the Assistant Secretary of the British Association, who will acknowledge all entries.

Special attention will be paid to the originality of the approach to the subject, and great importance will be attached to literary style. The competitor's age will also be taken into account. The essay winning the first prize will be published in *Advancement of Science*, journal of the British Association.

Automatic Control

THE University of Michigan college of engineering announced two intensive courses in automatic control. The first is scheduled for June 15 to 20, 1953, inclusive, and the second for June 22 to 25, 1953, inclusive.

The courses are built around the principles and application of measurement, communication, and control. Course 1 will consist of the fundamentals in each of these fields and will include some fundamental work in nonlinear systems. Course 2 will take up applications of the fundamentals to more advanced problems.

April 15, 1953, is the closing date for registration. Further information may be obtained by writing to Prof. M. H. Nichols, room 1523, East Engineering Building, University of Michigan, Ann Arbor, Mich.

Management

THE State University of Iowa college of engineering announced the fourteenth summer management course to be held June 15 through June 27, 1953, in Iowa City.

The areas of production planning, job evaluation, motion and time study, wage incentives, plant layout, materials handling, quality control, supervisory training, labor relations and legislation, organization and policy, and public speaking are included.

Queries and communications concerning the course should be sent to Wayne Deegan, 113 Engineering Building, State University of Iowa, Iowa City, Iowa.

Gas Turbines

THE department of mechanical engineering of the University of Michigan announced an intensive two-week course to be held June 29–July 10, 1953, at Ann Arbor, Mich., for engineers, professors contemplating courses in gas turbines, and members of the armed services having a direct interest in gas turbines.

The course includes lectures on the following: Thermodynamics of gas-turbine cycles; thermodynamics of propulsion, rockets, ramjets; thermodynamics of gas flow; centrifugal-compressor design; performance charts and testing techniques; axial-compressor design; axial-turbine design; radial-inflow-turbine design; heat exchangers; combustion; afterburners; stresses in blades and disks; fuel systems; materials; governing; fuels; applications to vehicles, and to aircraft.

Registrations and requests for information should be sent to Prof. F. L. Schwartz, 231 West Engineering Building, University of Michigan, Ann Arbor, Mich.

Traffic Engineering

YALE University offers a one-year course of graduate study in traffic engineering. This course is designed to give the student skill and ability in the analysis of highway-traffic problems and to provide a broad foundation in the techniques of traffic operation. The course of graduate study and research is open to men who have received a degree in engineering from an accredited college. Classes begin Sept. 21, 1953.

Courses of instruction include the study and analysis of the fundamental traits and behavior patterns of the road user and his vehicle in traffic; studies of statistical methods applicable to highway traffic; the theory, study, and practical application of regulatory measures; the design, application, and operation of traffic-control devices and aids; the influence of traffic operations on the design of road surfaces; the economic analysis of alternate designs and locations in the improvement of specific traffic facilities; the governmental and community organization and administration of traffic measures; and the application of highway-planning data and methods currently employed in state highway departments in the development of state highway systems.

There are available ten fellowships in traffic engineering for the academic year 1953–1954 which are awarded on a competitive basis to applicants who are residents of the continental United States. Nine of these awards have been made possible through a grant by the Automotive Safety Foundation, and one by Rand McNally and Company.

Applications for admission and special forms for fellowship application may be obtained by writing to the Director, Bureau of Highway Traffic, Yale University, Strathcona Hall, New Haven 11, Conn.

Fluid-Power Controls

AN advanced course in fluid-power controls will be given from July 6 to 17 during the 1953 summer activities at the Massachusetts Institute of Technology.

High lights of the program will include discussions of the fundamentals of fluid flow, new concepts of flow-valve performance and design, and the generation and utilization of compressible and incompressible fluid power. Analytical and simulation techniques for studying the dynamics of valve-controlled systems will be discussed, and there will be appropriate laboratory demonstrations.

The course will draw on recent work in the Dynamic Analysis and Control Laboratory on the control of high-inertia loads, the control of compressible fluid power, and the generation of fluid power.

Further information and application blanks for the summer program in fluid-power controls may be obtained from Prof. E. H. Huntress, Director of the M.I.T. Summer Session, Room 3-107, Cambridge 39, Mass.

Scholarships

TWO scholarship-award programs, available to the sons and daughters of company employees, were recently announced by Austenal Laboratories, Inc., and Handy and Harman.

The new Austenal Scholarship Program sponsored by the Erdle and Prange Foundation was launched by the awarding of five undergraduate scholarships to sons and daughters of employees of Austenal Laboratories, Inc.; C. H. Prange, Mem. ASME, is president of Austenal. The program is designed to provide liberal stipends renewable annually for the duration of the undergraduate or technical study.

The Scholarship Selection Committee is composed of Bernard Lester, Mem. ASME, management engineer, New York, N. Y.; J. M. Stalnaker, Association of American Medical Colleges, Chicago, Ill.; and W. L. Wallace, Psychological Corporation, New York, N. Y.

The Handy and Harman program announces winners of scholarships may keep them for a period of up to four years with a maximum of $1000 a year for each individual.

Applicants may select any field of study and are free to attend any accredited school or college, regardless of location. The awards will cover full tuition fees and up to three quarters of living costs and other essential expenses. The winners will be expected to earn a part of their expenses.

Sons and daughters of Handy and Harman employees, exclusive of officers and directors of the company, who will be graduated from high school in 1953, are eligible to apply. The only other requirement is that the applicant's mother or father must have completed at least two years' service with the company by Jan. 1, 1953.

The awards will be made on the basis of scholastic record, character, evidence of leadership, financial need, and benefits to be derived by the candidates. Selection of the winners will be made by a panel of three judges not connected with the company.

General Electric

THE General Electric Company announced expansion of its scholarships program to provide 100 grants of $500 each for college juniors, an increase of 70 over the current number. The additional grants were made as part of the company's observance of 75 years of electrical progress.

The scholarship will be granted to outstanding college juniors to assist them to complete their senior years.

Seventy of the scholarships for the 1953–1954 school year will be for technical students and 30 for nontechnical students in business administration, marketing, manufacturing, employee relations, and public relations.

The seventy college technical students will be selected from all sections of the country upon recommendations by the General Electric Professors' Conference Association. The association was formed by a group of college professors who have participated in summer programs conducted by G. E. over the past 30 years.

Awarding of the scholarships for the 1953–1954 school year is part of the General Electric Company's program to encourage interest in education and to help further alleviate the national shortage of trained manpower.

Armour Research Foundation

TWENTY high-school graduates a semester are now eligible for college educations without out-of-pocket expense.

That was the high point of an unusual cooperative scholarship plan announced by C. E. Barthel, Jr., assistant director, Armour Research Foundation of Illinois Institute of Technology.

Ten students will be eligible in metallurgical engineering and another 10 in mechanical engineering. The Foundation will pay the student's tuition for a degree at Illinois Institute of Technology, pay the student a $90 monthly stipend 12 months a year to start with, employ him in its laboratories to work with some of the world's leading engineers and scientists.

This is how the co-op program works: After the student passes entrance examinations and is accepted by the Foundation, he enrolls at Illinois Tech. For the first semester he attends regular classes.

During the second semester he drops his academic schedule and takes a full-time job with the Foundation. The monthly stipend continues whether he is attending school or working.

Dr. Barthel warned that since semester's classes start February 16, applications accompanied by a transcript of high-school credits should be received immediately.

Applications are to be addressed to Assistant Director for Personnel, Armour Research Foundation, Chicago 16, Ill.

Institute of Gas Technology

FIFTEEN fellowships will be offered in 1953 by the Institute of Gas Technology, an affiliate of Illinois Institute of Technology.

Two programs are available for graduate students preparing for careers in the gas industry. One offers a master of science degree in mechanical or chemical engineering in 15 months; the other, a master of gas-technology degree in two years. Outstanding students may be granted fellowship extensions for work on the doctor of philosophy degree.

It takes two summers and one full academic year to obtain a master's degree in mechanical or chemical engineering.

Application forms may be obtained from local gas companies or by writing the director of the Institute of Gas Technology, 17 West 34th Street, Chicago 16, Ill.

Junior Forum

Conducted by Joseph Schmerler[1]

Are Training Programs Overemphasized?

IN the past five or six years a trend has become manifest. Engineering graduates tend to gravitate to the large corporations for their initial employment. The reason for this march to the big companies is that the college campus has been subjected to well-organized recruitment programs. These companies circulate brochures which map the program that a prospective employee will undertake during his training period, outline the advancement procedures of the company, as well as present a documented picture of the working conditions and the security which are offered

Smaller companies are rarely able to make such an energetic appeal for employees. Their attempt at college interviews is usually only half hearted when made at all.

This concentration of interest by the graduates, in training programs, or employment by a large corporation, is understandable. The first large number of graduates to exhibit this tendency were those who emerged from the colleges shortly after World War II. About 70 per cent of these men were veterans of the war and their average age was between 23 and 24. They were unquestionably the most mature engineers ever to emerge from the schools.

Their maturity led to a realistic evaluation of what attitudes and preparations are necessary for a successful career in engineering. Coupled with this realization was a desire for security. The emphasis on proper training clearly pointed the way toward the large corporation where the young engineer felt he could gain experience under tutored supervision. Security, he reasoned, would follow when he finished the training program and his value to the company was increased. Even if the problem of security was not too dominant in the graduate's mind, he was still inclined to head for the big company in the belief that he would have better facilities to check his work, a greater library of previously compiled data, more opportunity to test a conclusion, and in general, acquire a surer footing in his early steps in the profession.

This pattern of thinking became established, and has continued, because senior students ask previous graduates for advice about where to apply for a job and also because the large companies have perfected their techniques of recruitment. So much have the big corporations cornered the market of the available graduates that smaller companies have resorted to the practice of waiting until an engineer finishes a training program before making him an offer. In this way they get a fairly well-trained engineer without engaging in a fight for his services and with a reduced risk in the possibility of his failure.

Such smaller companies, however, are still within the realm of size where engineering is conducted as a major part of the operation. They can resort to this alternative method of acquiring fresh engineering help. Below these companies in size, there exists a category where the operation is largely of a manufacturing nature with only limited application of consistent engineering to the business.

This type of manufacturing business would do well in the hands of an engineer. As a member of its management he could apply good production methods, proper equipment, and materials utilization, incentives for the labor staff, which would result in a superior competitive-market position. However, few recent graduates have gone into business for themselves, or have made themselves available for this work.

The condition of such businesses, today, does require the services of an engineer. When they were started, these operations succeeded because there was a clear need or desire for the product, because the price was right, and because the profit margin was adequate. The past five or ten years have seen a change in the sales and labor position without an appropriate change in the production position. The cost of manufacture has gone up beyond the point where an allowable increase in the selling price can offset the deficit. Commonly, very little has changed in the production method since the business was started.

Businesses of this nature are in need of en-

[1] Jun. ASME.

gineering assistance. What engineer can make the greatest contribution in such a program and how great will be his own benefit? Clearly, a young mechanical engineer fills the bill perfectly. A mechanical engineer is required because when a production method is antiquated a new method must be invented and this involves the development and application of equipment to lower the cost of production successfully and materially. This type of modernization endeavor is ideally suited for a young man. He has the unhampered vision, curiosity, and zest for development which is necessary to breathe new life into many established and possibly foundering businesses.

The reward which the engineer will get is equally as great as the benefit which the business will reap. His engineering development invites comparison with large company training-program progress.

The roads traveled by two men, one in a training program, the other directly in small manufacturing, have a primary and fundamental difference. The man as a trainee is led slowly. He is constantly under the supervision of others and does very little work which requires any uniqueness or originality. His work is checked, much in the manner in which an examination was graded while he was in school. The second man is violently torn from the mothering surroundings of his school. Engineering reality is thrust upon him.

A complete problem will be thrown at him. Where to start, and each succeeding decision will be entirely his. He will, normally, not have too many colleagues upon whom to rely for a hint at a solution when he is completely in the dark about a problem. He will make more mistakes than in the training program but he will learn more and will learn faster.

He will learn more because he will see the job through from its inception to its completion. He will partake of every facet in the investigation. He may personally have to do parts of the construction as well as make the preliminary calculations. Final erection, installation, and initial operation will also be his responsibility.

He will learn faster because, by actual participation in any operation, a more lasting and widely applicable impression is created. This young man will encounter numerous problems which he will be called upon to solve.

Besides a more rapid development as an engineer, additional benefit may accrue to this young man who learns by doing. His pay envelope may be fuller. He can show more positive accomplishment sooner than a man in a training program so that his remuneration will be correspondingly higher. His greater experience will create a more favorable bargaining position.

This comparison does not in any way incline to deprecate the value of a training program. Such a program of guidance is instituted by a company for the purpose of preparing young men for its future expansion and for their future advancement. Since the operation of such a corporation is a large one, efficient production necessarily calls for compartmented working range and supervision. The question of the rapidity and scope of the training as compared to that engaged in by an engineer in a small business is, however, another matter.

Actions of the ASME Executive Committee

At a Meeting at ASME Headquarters
February 19, 1953

A MEETING of the Executive Committee of the Council was held in the rooms of the Society on Feb. 19, 1953. F. S. Blackall, jr., chairman, presided. In addition to Mr. Blackall, there were present: H. E. Martin, A. C. Pasini, E. S. Theiss, and W. F. Thompson of the Committee; E. J. Kates, assistant treasurer; E. G. Bailey, past-president; C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary. The following actions were of general interest:

Dinner Meeting

A dinner meeting was held at The Engineers' Club on February 18, at which members of the Executive Committee met with ASME representatives on the United Engineering Trustees, Inc., the Engineering Foundation, and the Engineering Societies Library to discuss operating problems of those bodies. The following were present: F. S. Blackall, jr., H. E. Martin, A. C. Pasini, E. S. Theiss, and W. F. Thompson of the Executive Committee; P. R. Yopp, H. R. Kessler, and E. H. Hanhart, vice-presidents; E. J. Kates, assistant treasurer; R. F. Gagg, representative on UET; H. Weisberg and E. L. Robinson, representatives on The Engineering Foundation; F. M. Gilbreth, representative on Library; J. H. R. Arms, secretary, UET; Frank Sisco, director, The Engineering Foundation; R. H. Phelps, director, Library; C. E. Davies, secretary ASME; and Ernest Hartford, executive assistant secretary.

Progress in solving legal and related problems connected with a new Engineering Societies Building was reported by Mr. Gagg, president, UET. Later questions to be considered, he indicated, include desirability of additional societies and financing of the building. Society representatives on The Engineering Foundation and the Library also made progress reports.

Student Branches

Ways of improving the Society's Student Branch activities were reviewed by the vice-presidents at a recent meeting. They felt that the student mileage allotment should be increased and that each graduate should receive a communication from the Society. On their recommendation it was voted to increase the mileage allotment to Student Branch Conferences, subject to Finance Committee approval.

Distribution for this year only of a copy of W. J. King's paper, "The Unwritten Laws of Engineering," to each graduate who is a member of an ASME Student Branch was voted, subject to Finance Committee approval.

Section Appropriations

It was voted to modify Par. 12 of the 1952–1953 Budget Policies concerning Section appropriations by adding a provision for "supplementary payments equal to one third of a dollar for each paid-up member in the Section on September 30, this payment to be made only on a specific request from the Section showing necessity for it."

Seventy-Fifth Anniversary

The Board on Technology reported on plans being made for the Seventy-Fifth Anniversary of the Society in 1955 in Chicago. The Board was requested to proceed with perfecting plans with a budget, for presentation to Council at its Los Angeles meeting.

National Meetings

The Milwaukee Fall Meeting to be held Sept. 8–11, 1954, and the Baltimore Spring Meeting, 1955, were approved. Further information was requested from the Board on Technology about the Mexico City Special International Meeting in 1954.

IIRD Custodian Fund

Action on the establishment of the IIRD Dynamic Systems Committee Custodian Fund was held up, pending a special study to be made by the staff.

Committee on Society Policy

The following statement of purpose of the Committee on Society Policy was approved: "The Committee on Society Policy, advisory in character without operating responsibilities, will consider problems and ideas referred to it by the Council or developed in the Committee and which relate to the many phases of Society policy. The committee will report its finds to the Council."

Statement of Policy

A statement of policy on the formation of Sections, Subsections, and Groups was approved in principle. The Organization Committee will be asked to review it for possible changes in Society By-Laws.

Certificates of Award

Certificates of award were granted to the following retiring chairmen of Sections: Rolland S. Stover, Central-Iowa; and Wayland E. Loomis (posthumously), Hartford. Certificates were also granted to the following past-chairmen: R. M. Ferris, Sabine Subsection, 1949–1950; C. F. Quackenbush, Richland Group, 1947–1948; and G. R. Hosack, Richland Group, 1950–1951.

EJC Constitution

The following proposed amendment to the constitution of Engineers Joint Council was approved: Article I, insert new sentence identified as subsection (*c*) to read "to advance the science and profession of engineering."

UPADI Fund

It was voted to approve a loan of $4500 to UPADI by Engineers Joint Council for the immediate financial needs of UPADI and to advance money from the B-Development Fund to EJC as the ASME share of this loan.

Appointments

The following appointments of ASME representatives were approved: Engineers' Council for Professional Development, Inspection Committee, Region II, Karl B. McEachron, Jr., Edward McHugh, R. J. S. Pigott, George B. Thom, and Dennistoun W. VerPlanck; Engineers Joint Council, Survey Committee, H. N. Muller, Jr.; Atomic Energy Act, W. L. Cisler, and Creative Frontiers, Inc., Television, J. J. Jaklitsch, Jr.

The following presidential appointments were confirmed: Ben G. Elliott, Washington Award Commission Dinner, presentation 1953 award; J. Calvin Brown, inauguration of president, University of California, Los Angeles Campus, Warren H. McBryde, Berkeley Campus; and Alex D. Bailey, engineering centennial, University of Missouri.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th Street	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

Men Available[1]

Engineering Executive, 20 years' diversified experience directing production and engineering, including plant construction, equipment layout, manufacturing processes, research, and development. Background in manufacturing, public utilities, and shipyards. Me-949.

Mechanical Engineer, 33, married, BS; three years' diversified experience; three years 100,000-kw steam-power plant operation; five years assistant professor of mechanical engineering, teaching heat, power, and fluid flow; two years as hydraulic engineer. Desires position as professor or in industry. Me-950.

Mechanical Engineer, master's degree, four years' experience in oxygen plant; two years refinery piping, especially stress, thermodynamical and mathematical analysis. Presently employed mechanical engineer. Desires Canada. Me-951.

Management Executive, 39, BSME; MSIE, eighteen years' successful experience in administration, organization, consulting, sales, production in electrical, metal products, and research fields. Top-notch administrator, now employed, desires responsible management position. Me-952.

Positions Available

Consultant, engineering graduate, general executive management and production training experience, to take charge of program covering plant surveys and training of groups of foreign industrialists. Duration, one year or longer. $10,800, plus expenses. Europe. Y-8223.

Plant Superintendent, mechanical, industrial, or chemical-engineering degree, experience in plastic-products manufacturing, preferably now holding position as general foreman, assistant superintendent, or superintendent in a similar operation, and 10 to 15 years' responsible production experience in plastic products manufacturing. Will supervise vinyl molding, injection molding, production, assembly, and maintenance work for established plastic-products manufacturer. Will be responsible for labor relations, production, scheduling, methods, costs, etc. $7500–$10,000. Central Mass. Y-8228.

Methods Engineer, 30–40, mechanical graduate, five years' general machine-shop experience, to make up operations sheets and improve production methods for textile-machinery manufacturer. $6000–$6500. N. C. Y-8231.

Industrial Engineer, background in electrical engineering or electromechanical engineering methods, plant layout, machine-shop experience, production control, procedures, rotating electrical-equipment experience, time-study and incentive systems. Will report to the senior operating executive of the company, manufacturing a variety of electromechanical devices. Company employs 1000 people. Must be willing to locate in New England. $8000 and up. Y-8235.

Staff Engineers, 35–45, minimum of five to ten years' experience, preferably in consulting or industrial companies for large firm of consulting engineers. $8000–$14,000. New York, N. Y. Y-8248.

Executive Engineer, 35–50, experience in diesel-engine work preferred, but experience with internal-combustion-engine manufacture in some form acceptable. Company manufactures engines used both for driving electric power generators and in small locomotives. Will act as executive in charge of engineering and liaison between manufacturing and engineering. Will have full charge of scheduling orders into the manufacturing plant on new designs and will review all designs and have full authority to revise them. About $12,000. Midwest. Y-8250.

Chief Engineer, 40–50, mechanical graduate, considerable design experience on automatic machinery and automatic feeds on metal stamping and assembling equipment, to take charge of engineering staff and machine shop. $8000–$10,000. Brooklyn, N. Y. Y-8262.

Plant Manager, 38–50, mechanical degree preferred, with proved record of sound executive administration in the field of precision-parts manufacturing and assembly operations. Should have comprehensive knowledge of heavy machine-shop operations, including automatics, such as employed by high-production industries. To $25,000. Midwest. Y-8264-D-8290.

Staff Engineer, mechanical graduate, 40–45, with methods, production, accounting, and cost-analysis experience for metal-products manufacturer. $8000–$10,000. Newark, N. J. Y-8282.

Mechanical Engineer, 30–45, graduate, with several years of good power experience, to supervise about 125–130 employees. Company's equipment consists of boilers up to 200,000-lb per hour, turbogenerators, pumps, air compressors, etc. $6600–$7800. Ohio. Y-8284.

Mechanical Engineer, 35–40, graduate. Must have had experience in petroleum refinery and chemical-plant design. Must also have had experience in specifying and designing mechanical equipment from the process requirement specified for any project. $9000–$10,000. New York, N. Y. Y-8287(a).

Assistant Manager, 40–45, mechanical or mining graduate, at least ten years' mining and dredging, plant maintenance, and managerial experience. Must speak Spanish. $12,000. Latin America. Y-8295.

Materials-Handling Engineer, about 35, engineering graduate, at least five years' materials-handling, packaging, and warehousing experience, for paint manufacturer. Some traveling in East and Midwest. $10,000–$12,000. East. Y-8306.

Works Manager for small light metal and plastic fabricating plant, 35–50, engineering degree essential, preferably mechanical engineering. Prefer applicant with New England background. Will be fully responsible for all production and engineering, including quality control, labor relations, installation of tooling and machining, and all maintenance and purchasing except raw materials. $9000, plus incentive arrangement. Conn. Y-8308.

Methods Engineer, 35–50, for nationally-known manufacturer of machinery for use in the textile industry. Must have actual shop experience, capable of working directly with foremen on problems. Must have knowledge of, and be capable of managing a methods and time-study department. Will take charge of all methods and time-study activities. To $12,000. Eastern seaboard. Y-8316.

Chief Engineer, up to 45, mechanical degree preferred, qualified to organize a new department and supervise special-assignments program on product research and development of high speed automatic machinery. Will be responsible to vice-president in charge of manufacturing. Duties include making patent recommendations in behalf of company, employ outside engineering services on specialized problems, making suggestions to management, etc. Should be presently employed and earning a salary of $18,000 a year or more. $25,000, if qualified. Southeast. Y-8327-D-8320.

Vice-President of Operations, 45–55, for manufacturer of steel-pressure vessels, tanks, and containers. Should be graduate, preferably with heavy metalworking industrial experience. Knowledge of deep-drawing operations helpful. Will be responsible for all the operations of the company with the exception of finance, including production, labor relations, quality control, etc. Up to $30,000. Western Pa. Y-8336.

Engineers. (*a*) Mechanical engineer experienced in the layout and design of special-purpose machinery, to work in customer's machine-design section. Company designs and builds special machinery which includes certain brushing operations as required by customer's process. Administration ability helpful. $8000–$9000. (*b*) Checker to check the designs and details of the afore-mentioned equipment. Should also be capable of checking automatic manufacturing equipment designed for use in making high-production items. $6000–$7000. Conn. Y-8343.

Sales Engineers, about 40, mechanical training and five years' selling experience and knowledge of process industries. Will sell package steam generators and high-pressure steam equipment through distributors in chemical, food, dry-cleaning, dairy, and all process industries. Vacancies in Chicago, Omaha, and St. Paul. Chicago and Omaha men, $4200–$4800, plus expenses while training, about 60 days. Then $6000 drawing against 7 per cent commission. Traveling; car required. St. Paul man on straight salary. R-9623.

Die Designer and Estimator, up to 48, two or more years' experience in engineering department of metal-fabricating job shop. Knowledge of deep-drawn dies and stampings estimating desirable. Duties in engineering-department estimating, designing, and drafting deep-drawn dies. Willing to relocate later for advanced position, for a manufacturer of metalworking job shop. $5400–$6000. Company will negotiate placement fee. Ill. R-9626.

Product Designer, up to 35, mechanical engineer, at least three years' experience in designing products for mass production such as appliances or devices. Knowledge of materials and production equipment. Will solve unusual problems of product design, do board work, and calculate stresses and strains of materials for mass production, for industrial designers' company. $7000–$9000. Company will negotiate placement fee. Ill. R-9669.

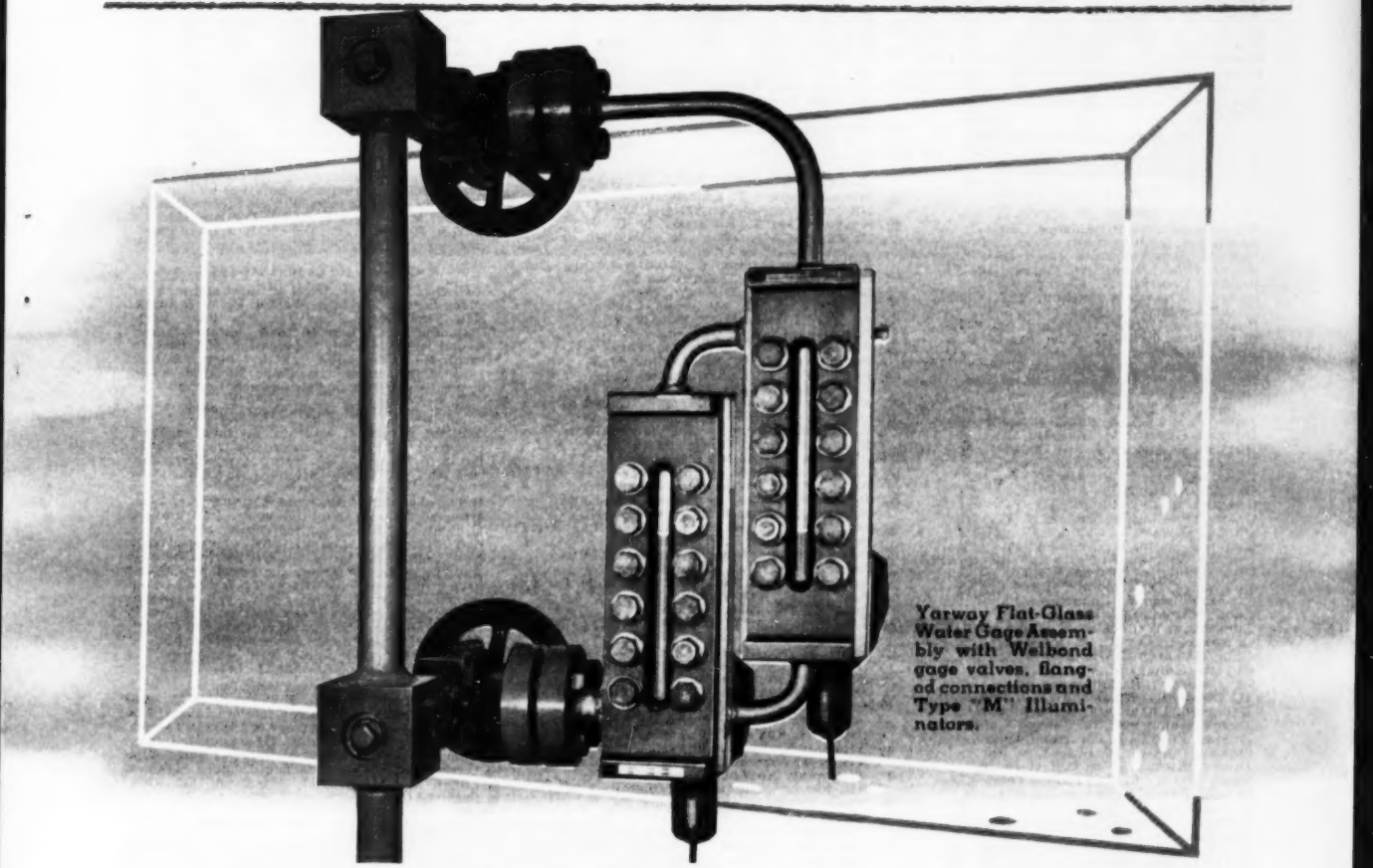
Research Engineer, 21–30, two to four years college, and experience in the design and manufacture of springs. Knowledge of materials testing, stress and vibration analysis. Will manage a research laboratory, write reports, and aid in design and production of seat cushions, frames, suspensions, and new products for manufacturer of truck and tractor seating. $5000–$6000. Company will negotiate placement fee. Wis. T-9686.

(*ASME News continued on page 356*)

[1] All men listed hold some form of ASME membership.

What's New

IN BOILER WATER LEVEL INDICATION?



Yarway Flat-Glass Water Gage Assembly with Welbond gage valves, flanged connections and Type "M" Illuminators.

NEW *SEPARATED-DESIGN* WATER GAGES

This new Yarway water gage assembly has been developed to meet the demands for greater dependability, longer life, and more accurate readings in high pressure service.

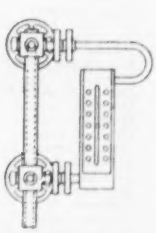
The gage glass inserts are of the Yarway pressure-sealed "floating assembly type". Yarway Welbond gage valves are used. Greater flexibility is gained by using two independent inserts, and by interconnecting expansion loops (see above).

The short connection to the drum assures greater accuracy of the gage reading, and the lower flanged connection eliminates a stuffing box. The upper flanged loop connection between the insert and gage valve allows expansion and contraction of the various components.

The tie bar-type water column linking the gage valves provides circulation to keep gage nearer drum temperature.

Yarway Type "M" Illuminators on the gage inserts cause the meniscus at water level to "shine like a star". This illuminator is especially effective in penetrating deposits on gage glass, dust particles in air and extraneous light.

For full information, write for Yarway Bulletin WG-1811.



Yarway Single Insert type gage for medium range of visibilities.

YARNALL-WARING COMPANY • 108 Mermaid Avenue, Philadelphia 18, Pa.

Branch Offices in Principal Cities

YARWAY *STEAM PLANT EQUIPMENT*

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after April 24, 1953, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

ALBRICH, MARTIN R., Alliance, Ohio
APELLÁNIZ, JOSÉ ANTONIO F., South Bend, Ind.
ARNOLD, BRUCE C., Rock Island, Ill.
AUGUSTYNIAK, ALFONS W., Chicago, Ill.
BARBER, LEONARD W., Chicago, Ill.
BARTHA, WILLIAM A., Stelton, N. J.
BEACH, GERALD H., Olean, N. Y.
BLACKBURN, GEORGE G., Johnstown, Pa.
BLACKWELL, EDWIN H., Charlotte, N. C.
BOON, EDMUND F., Delft, Holland
BOZEK, JOHN S., Franklin Park, Ill.
BRIGGEMAN, EUGENE R., Baltimore, Md.
BRETT, STANLEY R., Seattle, Wash.
BROWN, VAN THOMPSON, Nashville, Tenn.
BUMB, FRANK C., JR., Pasadena, Calif.
BURNAY, GILBERT M. H., Liege, Belgium
BUTTON, FREDERICK J., JR., Grosse Pointe, Mich.
CANJAR, LAWRENCE N., Pittsburgh, Pa.
CARBERY, JOHN F., Rockford, Ill.
CARTER, MALCOLM A., Atlanta, Ga.
CARVIN, PHILIP J., Flushing, N. Y.
CASE, JAMES J., Binghamton, N. Y.
CERNEK, ELWARD J., Chicago, Ill.
CHAPMAN, JAMES R., Wellesley Hills, Mass.
CHENEY, WALTER J., North Sacramento, Calif.
CHONA, BAIJ N., Allahabad, India
COBB, DEXTER W., Drexel Hill, Pa.
COLBERT, JOHN W., Johnstown, Pa.
COOK, RAYMOND C., Hialeah, Fla.
CORNEILLE, WALTER S., Whitemarsh, Pa.
COWGILL, HARRY B., JR., Pittsburgh, Pa.
CROM, WILLIAM H., JR., Rahway, N. J.
CUTLER, ROBERT M., New York, N. Y.
CZYZ, EDWARD P., Johnstown, Pa.
DE GREGORIIS, WILLIAM A., Wilmington, Del.
DIPUCCIO, CHARLES A., Lake Jackson, Texas
DRAKE, ROBERT M., JR., Albany, Calif.
DUFFY, WILLIAM J., Cleveland, Ohio
DUNNE, JOHN C., Ridgewood, N. J.
DUTTA, BIJOY K., West Bengal, India
EBBS, ROBERT E., JR., Dallas, Texas
ELLING, PETER W., Somerville, N. J.
EMIGH, CARL E., Johnstown, Pa.
EMIN, G. HERBERT, Chicago, Ill. (Rt&T)
EMMONS, NELSON, 3RD, Dayton, Ohio (Rt&T)
FAULK, GEORGE H., JR., San Antonio, Texas
FELDMAN, WALTHER H., Westfield, N. J.
FLANDERS, ERNEST V., Springfield, Vt.
FOGARTY, WILLIAM, Bergenfield, N. J.
FREDHOLD, ALLAN B., JR., Burbank, Calif.
FROUNFELKER, JOHN B., Vandalia, Ohio
FUNGER, ROBERT A., Wilmington, Del.
GALLOWAY, ROLLIN R., Royal Oak, Mich.
GANTZ, GORDON F., Wauwatosa, Wis.
GARRAUX, JOHN H., Charlotte, N. C.
GHERST, RICHARD H., Phoenixville, Pa.
GLOVER, ROBERT B., Weaverville, N. C.
GONDER, DOUGLAS V., Montreal, Que., Can.
GOOTHERTS, JEROME W., San Francisco, Calif.
GORDON, RALPH F., Chicago, Ill.
GORDON, LOWELL L., Philadelphia, Pa.
GREET, WILLIAM E., Sacramento, Calif.
HAGERTY, WILLIAM W., Ann Arbor, Mich. (Rt&T)
HALL, DAVID P., New York, N. Y.
HAMMITT, FREDERICK G., Madison, N. J.
HARDMAN, WALLACE J., Marietta, Ohio
HARDY, EARL P., Johnstown, Pa.
HARRIS, ELIOT H., New York, N. Y.
HEMBREE, FRANCIS E., Burbank, Calif.
HIGEL, HARRY, Jacksonville, Fla.
HOLDEN, JACK F., Rochester, N. Y.
HOWARD, FREDERICK H., London, Ont., Can.
HUTTON, GERALD H., Oakland, Calif. (Rt.)
IRBY, HOWARD E., Tulsa, Okla.
JACKSON, JOHN W., Chattanooga, Tenn.
JACOBSON, OLIVER H., Inglewood, Calif.
JETTER, ROY K., Mullica Hill, N. J.
JOHNSON, IVAN W., Johnson City, N. Y.
KERSH, PHILIP T., Columbus, Ohio
KLINGER, KARL A., Naperville, Ill.
KLUMPP, JAMES H., Minneapolis, Minn.
KRAHULA, JOSEPH L., Schenectady, N. Y.
LA RUE, ROBERT D., Rapid City, S. Dak.
LENNON, CHESLEY E., JR., Garland, Texas
LILLENAS, ARTHUR N., Minneapolis, Minn.
LITTLE, LAWSON, Boston, Ohio
LIZUT, OTTO H., Clifton Heights, Pa.
LOOMIS, BILLIE B., Erie, Pa.
LYBARGER, ROBERT C., Johnstown, Pa.
LYON, STERN A., Binghamton, N. Y.
MARAH, ROSCOE G., Dayton, Ohio
MARLOW, DAVID I., Los Angeles, Calif.
MARTIN, RENE J., JR., Atlanta, Ga. (RT & T)
MCCULLOUGH, RAY A., Oakmont, Pa.
MCGREENERY, PAUL A., JR., West Newton, Mass.
MCINNIS, JAMES C., Long Beach, Calif.
MCMAHON, RICHARD L., Houston, Texas
MCPHERSON, JOSEPH C., Kingston, Jamaica, B.W.I.
MIANO, PAUL J., Yonkers, N. Y.
MIDDLETON, WILLIAM H., Chicago, Ill.
MONTANA, ROBERT C., Nyack, N. Y.
MOORE, GEORGE T., Chicago, Ill.
NEIDERT, ANDREW R., Akron, Ohio
NELSON, CARL E., Rochester, N. Y.
NICKERSON, DOUGLAS B., Pasadena, Calif. (Rt&T)
NIXON, MELBOURNE E., Montreal, Que., Can.
ONOFREY, JOHN E., Johnstown, Pa.
OZKER, M. SACID, Dearborn, Mich.
PEARCE, CECIL H., Moratuwa, Ceylon
PHILIPP, HOWARD D., Buffalo, N. Y.
PICK, HANS, Jujuy, Argentina
PIERCE, JOEL C., San Antonio, Texas
PRICE, WILLIAM G., Binghamton, N. Y.
PRILL, WILLIAM K., Los Angeles, Calif.
PRIVAL, ELLIOTT C., Yonkers, N. Y.
PURCUPILE, JOHN C., Alhambra, Calif.
QUIRE, JOSEPH H., Dallas, Texas
RAOUF, MOHAMMAD A., Karachi, Pakistan
REPPIN, HERBERT D., JR., South Orange, N. J.
ROBERTS, RONALD M., Johnstown, Pa.
ROBINSON, GEORGE M., Philadelphia, Pa.
ROTHFUS, ROBERT R., Pittsburgh, Pa.
ROUSE, WALLACE T., Independence, Kan.
RUBINSTEIN, ALBERT H., New York, N. Y.
SCHNURE, WILLIAM H., Johnstown, Pa. (Rt&T)
SCIOTTI, ARKULE J., Windber, Pa.
SEN GUPTA, PROMODE R., Lucknow, India
SHAFFER, CLOYD E., Johnstown, Pa.
SHALLENBERGER, JOHN B., Connellsville, Pa.
SKINA, A. G., New York, N. Y.
SKINNER, DAVID H., Glassboro, N. J.
SLATER, ROBERT L., JR., Chicago, Ill.
SMITH, HARRY V., Newark, Ohio
SMITH, ORIN A., Harrison, N. J.
SNOW, PAUL E., Towanda, Ill.
SORENSON, RICHARD J., Hammond, Ind.
STALLER, CHARLES V., Canton, Ohio
STEVENS, JOHN E., Chicago, Ill.
SUHS, GERHARD W., Hammond, Ind.
SWEENEY, EDWARD H., Media, Pa.
TIDBALL, ROBERT A., Callery, Pa.
TIMANUS, WILLIAM R., Baltimore, Md.
TIMMENEY, ARTHUR S., Johnstown, Pa.
TITTERTON, GEORGE E., Florham Park, N. J.
TODD, EDWIN M., Philadelphia, Pa.
TREXLER, EDWIN W., Johnstown, Pa.
TREXLER, HENRY F., Clemson, S. C.
VAN NEST, FRANCIS H., Marblehead, Mass.
VENABLE, JOHN E., Madison, Ohio
VICKERS, PAUL T., Royal Oak, Mich.
VOGT, JOHN F., JR., New Orleans, La.
WALDROP, EDWARD D., Arab, Ala.
WALSH, DENIS P., Chicago, Ill.
WATERHOUSE, FRANK M., Wilmington, Del.
WATTS, HERBERT E., Brooklyn, N. Y.
WEAVER, EDGAR L., Saginaw, Mich. (Rt&T)
WEBB, THOMAS B., London, England
WEHMER, FRED J., Saint Paul, Minn.
WESTCOTT, RALPH M., La Canada, Calif.
WHITMORE, CHARLES H., Minneapolis, Minn.
WINSLOW, EVERETT S., Saco, Me.
WINTERMARK, CHARLES R., New York, N. Y.
WITTMER, RUSSELL J., Merion Station, Pa.
WRIGHT, BERYLE W., Portland, Ore.
WRIGHT, ROBERT A., Detroit, Mich.
YEH, TE FUNG, Chicago, Ill.
YOUNG, JAMES W., Johnstown, Pa.
ZIMMERMANN, FRANCIS J., West Roxbury, Mass.

CHANGE IN GRADING

Transfers to Member and Associate

ALLEN, ROBERT D., New Orleans, La.
BAVETTA, VINCENT E., Brooklyn, N. Y.
DEMOREST, GEORGE E., Detroit, Mich.
HUGHES, ARTHUR J., New York, N. Y.
KURK, ELMER F., Louisville, Ky.
MCGEE, HUGH P., Mystic, Conn.
NEWHALL, DONALD H., Walpole, Mass.
OSTROGNAI, ALLEN G., Milford, Conn.
PUTNAM, ABBOTT A., Columbus, Ohio
RAI, BRIJ BHUSHAN, Brooklyn, N. Y.
RAMSDELL, R. G., JR., Rockville Center, N. Y.
SCHLATTER, HUGO, Kingston, N. Y.
SNIDER, ANDREW J., 3RD, Chicago, Ill.
SNYDER, HARRY W., Little Falls, N. Y.
STEVENS, PAUL V., Fall River, Mass.
TODD, LEONARD M., New York, N. Y.
VELKOBORSKY, VLADIMIR G., San Francisco, Calif.
WHITAKER, CHARLES H., Baltimore, Md.

Transfer from Student Member to Junior.....109

Obituaries

William Brayton Burlingame (1868–1953)

WILLIAM B. BURLINGAME, retired consulting mechanical engineer, died Jan. 23, 1953, at his home in Exeter, N. H. Born, Exeter, N. H., Sept. 10, 1868. Parents, William and Amy Agnes (Carter) Burlingame. Education, Phillips Exeter Academy, 1889; special courses, Massachusetts Institute of Technology. Married Minnie Jewett De Merritte, 1890 (died 1934). Mem. ASME, 1938. For many years Mr. Burlingame had brought with him a deserving high-school senior to attend the ASME Annual Meeting. Several of the boys are today enjoying interesting and creative engineering practices. Survived by a daughter, Agnes, and two sons, William L., Stephen D.; a sister, Mrs. Henry L. Lewis, Portland, Me.; a brother, Robert A., Bethlehem, Pa.; three grandchildren and two great-grandchildren.

Cecil Imbrie Cady (1888–1953)

CECIL I. CADY, electrical engineer and member of the firm of Voorhees, Walker, Foley & Smith, New York, N. Y., died Jan. 31, 1953. Born, Ossining, N. Y., June 21, 1888. Parents, Sidney B. and Jennie N. Cady. Education, ME, Stevens Institute of Technology, 1910. Mem. ASME, 1922. Survived by wife, Paula L. Cady, whom he married in 1914, and a daughter, Barbara L.

Basil Sawley Cain (1899–1953)

BASIL S. CAIN, assistant division engineer, Locomotive Division, General Electric Co., Erie, Pa., died Jan. 5, 1953. Born, Manchester, England, Oct. 18, 1899. Parents, John C. and Amy (Brown) Cain. Education, MA, Cambridge University, 1921; BS, London University, 1921; attended University of Grenoble. Naturalized U. S. citizen, Erie, Pa., September, 1939. Married Elizabeth R. Gifford, 1926. He received a C. A. Coffin Award from General Electric Co. He was the author of several technical papers and held a number of patents in the railroad-equipment field. Mem. ASME, 1935; Fellow ASME, 1947. Survived by wife, a daughter, Mrs. Jon P. Kunstle, Albany, N. Y.; his mother, and a sister, Mrs. Evelyn Boardman, Belmont, Mass.

Clarence Robert Callaway (1887–1952)

CLARENCE R. CALLAWAY, chief engineer, Watson Elevator Co., Inc., Englewood, N. J., died Nov. 3, 1952, at his home in Fort Myers, Fla. Born, Honesdale, Pa., Dec. 12, 1887. Parents, Thomas E. and Sarah E. (Hawkey) Callaway. Education, high-school graduate; studied engineering subjects at evening school. Married Lillian McElwain, 1921. Mem. ASME, 1921. Survived by wife.

John Adlum Dent (1885–1953)

JOHN A. DENT, associate professor, mechanical engineering, University of Florida, died at his home in Gainesville, Fla., Jan. 20, 1953. Born, Brookland, Pa., Jan. 16, 1885. Parents, William and Frances Elliott (Johnstone) Dent. Education, ME, Lehigh University, 1905; postgraduate study, University of Illinois. Co-author of "Kinematics" and "Kinetics of Machinery." Jun. ASME, 1911; Assoc-Mem. ASME, 1916; Mem. ASME, 1925.

Walter Edward Dunham (1873–1952)

WALTER E. DUNHAM, retired superintendent, car department, Chicago & Northwestern Railway, died Dec. 2, 1952. Born, Newark, N. J., Sept. 9, 1873. Parents, Huber and Helen L. (Dauchy) Dunham. Education, ME(EE), Cornell University, 1895. Married Belle Shellabarger, 1899; children, George S., Barbara E. Mem. ASME, 1914.

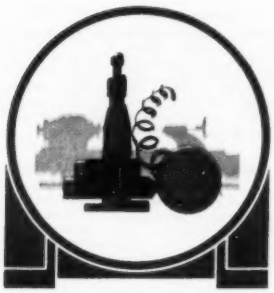
Humphrey Alfred Ellis (1871–1952)

H. ALFRED ELLIS, combustion consulting engineer, died in St. Petersburg, Fla., Dec. 15, 1952. Born, Derry, Pa., March 22, 1871. Education, high-school graduate. He designed and developed the Ellis tuyeres for power-plant stokers; Ellis combustion system; and held several U. S. Patents on improvements to stoker operation covering chain grates and underfeed stokers. Mem. ASME, 1939. Survived by wife, Edith Law Ellis; a son, Dr. William A., Grand Rapids, Mich., a son-in-law, G. E. Willis, Fort Wayne, Ind.; seven grandchildren, and one great-grandchild.

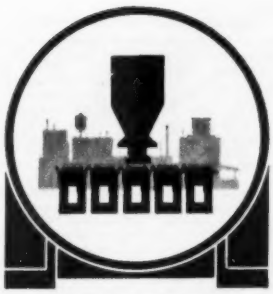
Michael Henry Flynn (1875–1952)

MICHAEL H. FLYNN, methods and layout engineer, Royal Typewriter Co., Hartford, Conn., died Dec. 13, 1952. Born, Tariffville, Conn., Oct. 8, 1875. Parents, Michael A. and Rachel (Ledyard) Flynn. Education, graduate, Hillyer

(*ASME News continued on page 358*)



Metal Working



Food Processing

Grain Handling

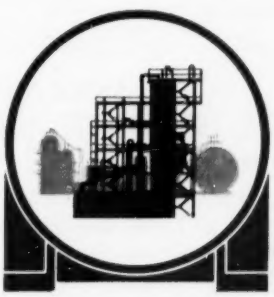
Electric Motors

for every industry

When you need electric motors . . . in any rating, or frame type . . . one or a thousand . . . *always* look for the Fairbanks-Morse Seal. For over 120 years it has stood for the finest in manufacturing integrity to *all* industry.

Fairbanks, Morse & Co., Chicago 5, Illinois.

Chemical Processing



Petroleum Refining

Fairbanks-Morse totally-enclosed, fan cooled motor—in a complete horsepower range.

FAIRBANKS-MORSE

a name worth remembering when you want the best

ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • RAIL CARS • PUMPS • SCALES • HOME WATER SERVICE EQUIPMENT • FARM MACHINERY • MAGNETOS

institute; completed ICS engineering course. Married Elizabeth Condron, 1906; children, Edward H., John C. Mem. ASME, 1913. Served the Society as a member, Bolt and Nut Committee, Subcommittee No. 9, 1929–1934. Held many U. S. Patents on typewriter tools, screws, and swaging machines.

Edward Beach Gallaher (1873–1953)

EDWARD B. GALLAHER, who owned and operated Clover Manufacturing Co., makers of coated abrasives, Norwalk, Conn., died Jan. 9, 1953. Born of American parents in Paris, France, April 28, 1873. Education, ME, Stevens Institute of Technology, 1894. He was recognized as an expert in street-railway engineering and construction and was one of the earliest automobile manufacturers in the United States. In 1903 he took out a basic patent on a grinding and lapping compound, Clover Compound, the first to be manufactured in America. He published monthly the "Clover Business Letter." Mem. ASME, 1919; Fellow ASME, 1949. Survived by wife, Inez H. Gallaher.

Earl Downing Hay (1885–1953)

EARL D. HAY, professor of mechanical engineering, Iowa State College, died Jan. 1, 1953. Born, New Goshen, Ind., Sept. 19, 1886. Parents, Walter B. and Valora Adela (Downing) Hay. Education, BS, Rose Polytechnic Institute, 1910; MS, 1915; ME, 1921; graduate student, University of Wisconsin, 1911–1912. Married, Bessie Louise Whipp, 1913. Assoc-Mem. ASME, 1918; Mem. ASME, 1920; Fellow ASME, 1952. Served the Society as chairman, Kansas City Section, 1939–1940; secretary-treasurer, Central Iowa Section, 1946–1947; chairman, Central Iowa Section, 1948–1949. Coauthor: "Trade Foundations," 1918; "Education Through Woodworking," 1923. Contributed articles to technical journals. He was the Kansas delegate to the World Power Conference, 1936. Survived by wife, mother, three daughters, Mrs. Charles Hazen, Coulee Dam Wash.; Mrs. James T. Kepner, Itasca, Ill.; Mrs. Helen Richardson, Menlo Park, Calif.; a son, David E., Des Moines, Iowa; a sister, Mrs. O. P. Hutchinson, Muskegan, Mich.; and four grandchildren.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

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David Gerard Iliff (1901–1952)

DAVID G. ILIFF, mechanical engineer, Ebasco Services, Inc., New York, N. Y., died Dec. 30, 1952. Born, Crawfordsville, Ind., May 19, 1901. Education, BS(ME), University of Michigan, 1923. Mem. ASME, 1948. Survived by wife, Althea W.; a son, David G., Jr.; a daughter, Althea M.; and two sisters, Mrs. Robert Bertsch and Mrs. A. M. Feemster.

Arthur John Leighton (1888–1951)

ARTHUR J. LEIGHTON, whose death was recently reported to the Society as having occurred July 28, 1951, was a sales engineer, The Babcock & Wilcox Co., Chicago, Ill. Born, Sanbornton, N. H., Dec. 31, 1888. Education, BS(ME), University of New Hampshire, 1912. Mem. ASME, 1932.

Daniel B. McNeill (1909–1953)

DANIEL B. MCNEILL, design draftsman, Howard Hughes Aircraft Co., Tucson, Ariz., died Jan. 2, 1953. Born, Kansas City, Mo., Dec. 30, 1909. Education, BS(ME), Finley Engineering College, 1947. Jun. ASME, 1951. Survived by wife.

William Randolph Moore, Jr. (1894–1952)

WILLIAM R. MOORE, JR., design engineer, Fairchild Engine and Airplane Corp., Hagerstown, Md., died Dec. 5, 1952. Born, Roanoke, Va., Jan. 29, 1894. Education, graduate, Baltimore Polytechnic Institute, 1913; BA(ME), Swarthmore College, 1917. He held many U. S. Patents in the field of machine design. Mem. ASME, 1951. Survived by wife, Louise W. Moore.

William Thomson Mowatt (1883–1952)

WILLIAM T. MOWATT, mechanical engineer of Alameda, Calif., died Nov. 5, 1952. Born, Orkney Isles, Scotland, March 6, 1883. Education, 4 years during apprenticeship, Glasgow Evening Technical College; graduate, University of California (evening), Smith Hughes teachers' training course. Mem. ASME, 1928. Survived by wife, Janet M. Mowatt.

Stuart Paige (1918–1952)

STUART PAIGE, area supervisor, Remington Arms Co., Inc., Bridgeport, Conn., died March 28, 1952. Born, Melrose, Mass., April 10, 1918. Parents, Clifford E. and Alice (Perry) Paige. Education, BS(Bus. and ME), Massachusetts Institute of Technology, 1939. Married, Arlyne Reilly, 1943. Jun. ASME, 1950. Survived by wife, two sons, Clifford E., Edward P.; parents, a sister, Marjorie Teller, Old Greenwich, Conn.; a brother, Lincoln, Larchmont, N. Y.

Arthur Raphael Smith (1879–1952)

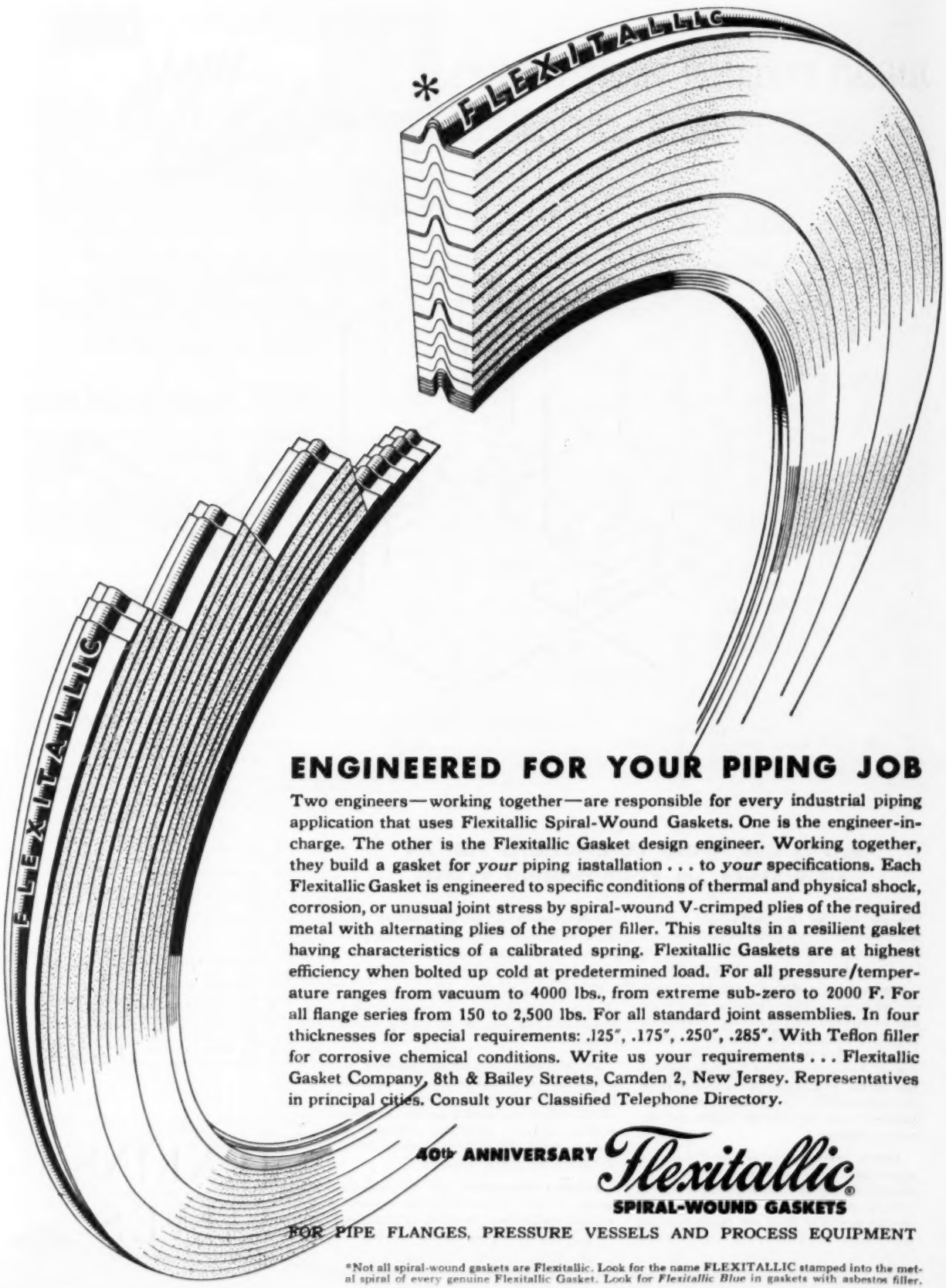
ARTHUR R. SMITH, former managing engineer, turbine-generator engineering division, General Electric Co., Schenectady, N. Y., died Dec. 31, 1952. Born, Schenectady, N. Y., May 2, 1879. Parents, Charles and Mary (Fitzmorris) Smith. Education, high-school graduate; ICS. Married Rose Macauley, 1908 (deceased). In 1928 he received the C. A. Coffin Award for his contribution to the invention of the double-winding generator. He held more than 25 U. S. Patents and was the author of many technical papers. He was an original officer and member of the Mohawk Development Corp., a Schenectady company which employed retired professional men. Mem. ASME, 1922; Fellow ASME, 1941. Survived by a daughter, Mrs. Lauman Martin, Skaneateles, N. Y.; three sons, J. Vincent, Morris R., Clement A., Morgantown, W. Va.; and a sister, Rose E. Smith.

George Gowen Thorp (1868–1953)

GEORGE G. THORP, former president of the old Illinois Steel Co., who in 1906 supervised the design, construction, and operation of the Gary (Ind.) steel works now owned by the United States Steel Corp., died Jan. 19, 1953, at his home in Madison, Wis. Born, Pittsburgh, Pa., June 29, 1868. Parents, John M. and Jane Helen (Veeder) Thorp. Education BME, University of Wisconsin, 1891; Fellowship in Engineering, 1891–1892. Married Estelle Brown, 1900; children, Jane (Mrs. Woodbridge) Bissell, Harriet (Mrs. Arthur) Dailey, Barbara (Mrs. John E.) Blunt. Jun. ASME, 1892; Mem. ASME, 1904.

Nicholas McLean Trapnell (1900–1953)

NICHOLAS M. TRAPNELL, partner, Hankins & Trapnell, consulting engineers, Richmond, Va., died Jan. 21, 1953. Born, Elizabeth, N. J., Dec. 30, 1900. Parents, Benjamin and Ada (Probasco) Trapnell. Education, graduate, Stevens Preparatory School, 1918; Stevens Institute of Technology, 1918–1921. Married Fortunata Kirkpatrick, 1921; children, Mary H., Nicholas M., Jr., Sydnor. Assoc-Mem. ASME, 1928; Mem. ASME, 1935. He was currently serving the Society as chairman, Virginia Section.



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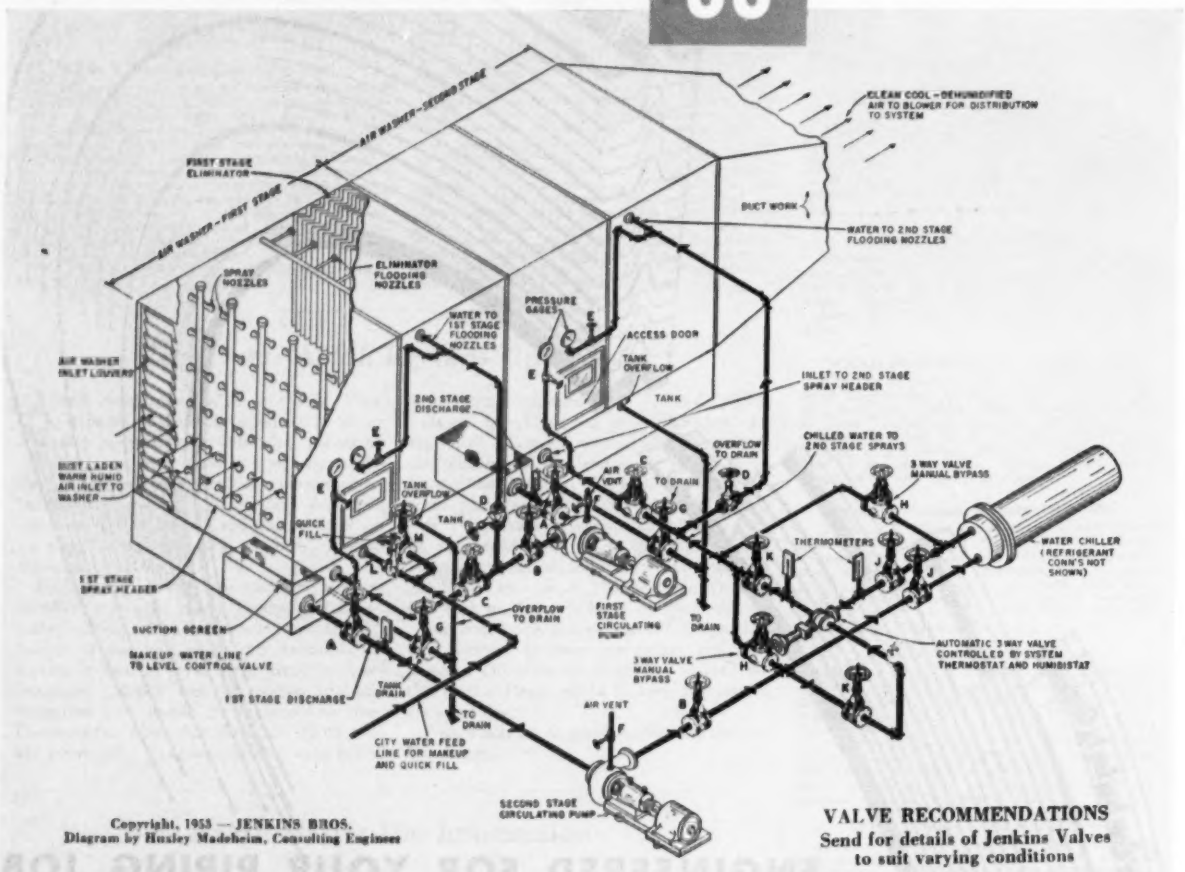
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WATER TO 2ND STAGE FLOODING NOZZLES
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PRESSURE GAGES
WATER TO 1ST STAGE FLOODING NOZZLES
ACCESS DOOR
AIR WASHER INLET LOUVERS
TANK OVERFLOW
TANK
INLET TO 2ND STAGE SPRAY HEADER
2ND STAGE DISCHARGE
OVERFLOW TO DRAIN
CHILLED WATER TO 2ND STAGE SPRAYS
3 WAY VALVE MANUAL BYPASS
DUST LADEN WARM HUMID AIR INLET TO WASHER
AIR VENT
TO DRAIN
QUICK FILL
TANK
THERMOMETERS
WATER CHILLER (REFRIGERANT CONN'S NOT SHOWN)
1ST STAGE SPRAY HEADER
SUCTION SCREEN
OVERFLOW TO DRAIN
FIRST STAGE CIRCULATING PUMP
TO DRAIN
AUTOMATIC 3 WAY VALVE CONTROLLED BY SYSTEM THERMOSTAT AND HUMIDISTAT
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3 WAY VALVE MANUAL BYPASS
1ST STAGE DISCHARGE
TANK DRAIN
AIR VENT
TO DRAIN
CITY WATER FEED LINE FOR MAKEUP AND QUICK FILL
SECOND STAGE CIRCULATING PUMP

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Code	Quan.	Jenkins Valve	Services
A	2	Fig. 651-A, I.B.B.M. Gate	Pump Suction Shutoff
B	2	Fig. 651-A, I.B.B.M. Gate	Pump Discharge Shutoff
C	2	Fig. 142, I.B.B.M. Globe	Spray Header Control
D	2	Fig. 956, Bronze Globe	Flooding Nozzle Control
E	4	Fig. 741-G, Bronze Needle	Pressure Gage Control
F	2	Fig. 741-G, Bronze Needle	Pump Air Vents
G	2	Fig. 651-A, I.B.B.M. Gate	Tank Drains
H	2	Fig. 142, I.B.B.M. Globe	3 Way Valve Manual By-Pass
I	2	Fig. 651-A, I.B.B.M. Gate	Water Chiller Shutoff
K	2	Fig. 651-A, I.B.B.M. Gate	3 Way Valve Shutoff
L	2	Fig. 47, Bronze Gate	Feed to Level Control
M	1	Fig. 651-A, I.B.B.M. Gate	Tank Fill Valve for Start up

How to plan PIPING CONNECTIONS FOR AN AIR-WASHER AIR CONDITIONING SYSTEM

The air washer air conditioning system illustrated is a two-stage installation designed to cool, dehumidify and clean air for non-industrial (comfort) purposes.

Water from a chiller, sprayed through second-stage nozzles, picks up heat from the air stream. This water is collected at the bottom of the tank and, still at a temperature below the dew-point of the entering air-stream, is sprayed through the nozzles of the first stage. Here, too, it cools and dehumidifies the air. The water is then pumped back through the chiller and the cycle is repeated.

Excess moisture is removed between stages by a series of baffles which set up abrupt directional changes in the air flow, causing any droplets of water suspended in the air stream to drop out. Separate water spray keeps the baffles wet to collect dust and dirt from the air stream. Final air condition is automatically controlled by proportionate mixing of chilled and return water by means of a three way valve.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installation.

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Those in industry who are responsible for various phases of plant, machinery, and product design, production, operating and application engineering will find much to interest them in this NEW CATALOGS Guide. Here, reputable manufacturers, most of whom have current advertising in MECHANICAL ENGINEERING and ASME MECHANICAL CATALOG AND DIRECTORY, offer to send you without obligation, their latest literature which is described on pages 43 to 78. Make use of the coupon on page 42.

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Foster Wheeler Corp.—A new illustrated, 36-page catalog on cooling towers contains details of construction, charts, suggestions on recirculation, and surroundings. It also includes "Inquiry Data Sheet" for planning requirements.

4 PACKAGED AUTOMATIC BOILERS

Orr & Sembower, Inc.—Bulletin 1219 describes Powermaster packaged automatic boilers in sizes from 15 through 500 hp for steam process and steam and hot-water heating service. The first portion of the bulletin covers the construction features of boilers of this type. Detailed specifications describe the boiler, burner, and control systems. Several typical installations are included.

5 DRAFTING EQUIPMENT

Frederick Post Co.—Recently revised illustrated 170-page Catalog thoroughly describes a complete line of print-making products, tracing papers and cloths, drafting materials and equipment for the drafting room, and supplies for field engineering Indexing system saves time in finding desired information.

6 VANEAXIAL FANS

Joy Mfg. Co.—Bulletin J-611 describes the Axivane Series 1000 fans and explains the advantages of vaneaxial design and the versatility of adjustable blades. Series 1000 has 136 models, 18 to 84 in. in diameter, and producing volumes up to 150,000 cmf at total pressures as high as 11.0 in wg. Fans are available in 19 housing diameters, four hub sizes, and five motor speeds. Specification tables are included.

7 BALL AND ROLLER BEARINGS

Aetna Ball and Roller Bearing Co.—Latest 52-page catalog gives specifications on Aetna's full line of standard ball thrust bearings, clutch release bearings, ball retainers, and hardened and ground washers. Contains technical data for design engineers, useful calculations and formulas, important application principles, fundamentals of proper lubrication, bearing selection and care.

8 STAINLESS STEEL

Sharon Steel Corp.—A 12-page illustrated booklet describes Sharon 430 stainless steel, an all-purpose stainless steel. Chemical analysis, typical mechanical properties, and physical properties are given, and fabricating characteristics are discussed. A list of typical applications is appended.

9 ANNUNCIATOR SYSTEM

Panalarm Products, Inc.—The Panalarm "50" Annunciator system is described in Bulletin 100. The advantages of flexibility and standard interchangeable units are explained. Wiring diagrams of different annunciator-sequence circuits and explanations of the different sequences possible are contained in the bulletin. Excerpts from the 1947 National Electric Code are quoted regarding locations and equipment.

10 MULTI-STAGE PUMPS

Food Machinery & Chemical Corp., Peerless Pump Div.—Bulletin No. B-1400 describes in detail and completely illustrates with technical data a complete line of 2-, 3-, 4-, and 5-stage pumps for boosting and circulating hot and cold water and clear liquids against medium and high heads. Pumps are of split-case design and are available for capacities up to 3,000 gpm. Head ranges up to 1600 ft are offered, and all types of drive.

11 TUBE FITTINGS

Parker Appliance Co.—Catalog 4300 provides a full description of Trinle-lok flare tube fittings and Ferulok flareless tube fittings, as well as tube-fabricating tools and equipment. Included are sections on use of tools and selection of tube sizes and materials according to operating conditions.

12 RUST PREVENTIVES

Rust-Oleum Corp.—Catalog 252, a new 16-page general catalog, lists industrial rust-preventive applications. Instructions for surface preparation and application of Rust-Oleum products and 73 color chips of Rust-Oleum products are contained in the catalog.

13 NYLON-LINED BEARINGS

Thomson Industries, Inc.—New Bulletin describes the Nylined design principle. Bearings consist of thin drawn steel outer sleeve and free floating nylon liner. Now available in ten sizes from 1/4 in. to 1 1/4 in. ID, the bearings are engineered to provide low-cost solution to common bearing problems. Advantages claimed are that these bearings resist poundout; permit dry operation; are abrasion-resistant, corrosion-resistant, and quiet; dampen vibration; operate in liquids; are close-fit, non-contaminating, low-friction, compact, and lightest in weight; and have a replaceable bearing surface.

14 DRAWING EQUIPMENT

F. Weber Co.—A supplementary Catalog, Vol. 853, shows and describes the Weber-Riefler Original Round System Drawing Instruments, Weber-Ott Precision Planimeters, and slide rules, scales and other supplies for draftsmen, architects, and engineers.

15 LIQUEFIED GASES

Arthur D. Little, Inc.—New catalog summarizes work with the production, handling, and storage of liquefied gases. It also includes a description of a high field strength electromagnet and a review of prototype development service. The Mechanical Division of Arthur D. Little, Inc., provides science and industry with a means of developing unique prototype equipment, particularly in the areas of thermodynamics, heat transfer, refrigeration to −456 F, vacuum engineering, gas liquefaction, electromagnetism, mechanical design, and vibration.

16 HIGH-STRENGTH WELDABLE STEEL

United States Steel Corp.—Folder T-1 describes USS Carilloy "T" steels, designed to have high strength and still retain toughness and weldability superior to other high-strength steels. Mechanical properties are listed and toughness, welding ability, fabricating procedures, and resistance to atmospheric corrosion, wear, and abrasion discussed.

17 ELECTROSTATIC PRECIPITATORS

Koppers Co., Inc.—Precipitator Dept.—Folder describes Koppers Elex electrostatic precipitators in features and performance. Specific operating results are given as well as suggested applications in nuisance elimination, cleaning of process gases, or recovery of valuable products.

18 TESTING MACHINES

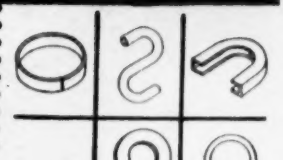
Baldwin-Lima-Hamilton Corp., Testing Equipment Dept.—Bulletin 4204, 4 pages, describes and illustrates newly improved models of Baldwin low-cost universal testing machines of 60,000- and 20,000-lb capacity (60-H and 20-H) having hydraulic loading and hydraulic load measurement by either precision Bourdon tube or still more accurate Tate-Emery indicator.

19 FACILITIES AND PRODUCTS

Newport News Shipbuilding & Dry Dock Co.—Bulletin contains illustrations and information on the facilities and products other than shipbuilding of the Newport News company. Steel fabrication, subassembly methods, sheet metal facilities, machine shops, forging, and foundries are featured in the publication.

20 HYDRAULIC PUMPS, MOTORS, TRANSMISSIONS

Oliver Iron & Steel Corp., Berry Div.—Catalog No. 5209 describes the Berry hydraulic principle used in its motors, pumps, and transmissions. Diagrams illustrate its operation. Hydraulic cir-



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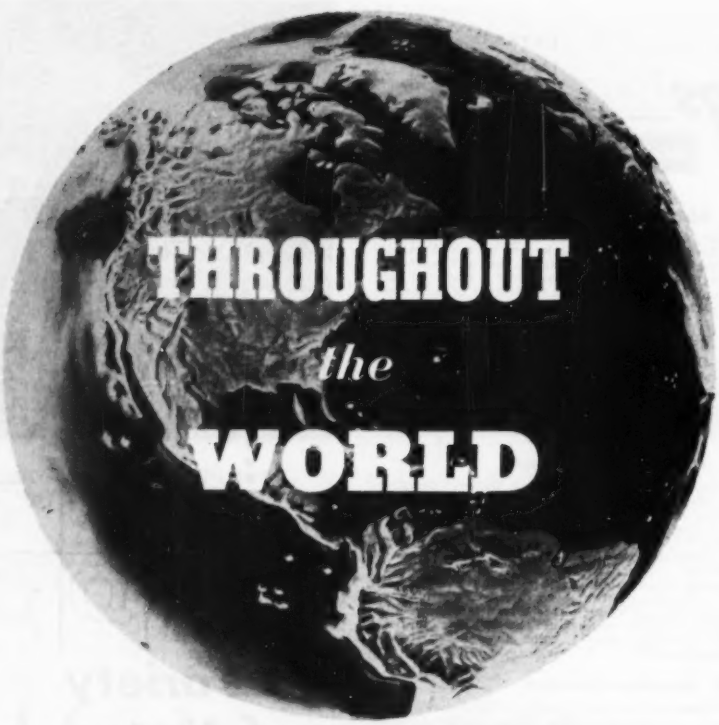

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cuits with motors, pumps, and transmissions are included, together with motor and pump ratings and engineering information.

21 INVESTMENT CASTINGS

Precision Metalsmiths, Inc.—"Pour Yourself an Assembly With Investment Castings" explains the investment-casting process. Illustrations of the difficult castings that can be made by the investment-casting process and a step-by-step description of the procedures used by the company are included in the 8-page booklet.

22 INSTRUMENT BALL BEARINGS

New Hampshire Ball Bearings, Inc.—Catalog No. 53 describes the Micro precision instrument ball bearings, in sizes from 1/2 in. OD to 0.0250 in. bore. Tolerances are ABEC 5 or better. Chrome and rtainless steel and beryllium copper are used. A variety of types are available, specifications for each of which are contained in the catalog.

23 UNIVERSAL JOINTS

Apex Machine & Tool Co.—Catalog 27 contains 32 pages of information on Apex heavy-duty universal joints for aircraft and industrial applications. Types of joints and specifications as well as several data sheets are included.

24 MECHANICAL SEALS

Rotary Seal Co.—"Sealing With Certainty on Rotating Shafts" is a 12-page booklet that discusses mechanical seals and their components in general and illustrates typical applications. Dimensions of the Rotary Seal assemblies are in tabular form. Included is a list of types of equipment in which Rotary Seals are used.

25 GAGES

American Machine & Metals, Inc., U.S. Gauge Div.—Catalog 64 provides 68 pages of illustrated information describing air-volume controls for pump installations, vapor-tension thermometers, d-c ammeters and voltmeters, and water flow meters. Engineering information is included.

26 LIQUID FILTERS

Dollinger Corp.—New Catalog describes complete line of Staynew Liquid Filters. This catalog contains specifications, engineering and performance data, photos and descriptions of recommended types of filter media, and a check list of liquids that can be filtered. In addition, it has cutaway drawings to illustrate construction features and the Staynew principle.

27 BALL BEARINGS

Marlin-Rockwell Corp.—Bulletin No. 26 contains a list of bearing numbers of over 14,000 different ball bearings made by the various American ball bearing manufacturers. The bearing numbers for each manufacturer are arranged numerically, so that any particular number can be readily found. MRC replacement number for each is given.

28 CRANES AND HOISTS

Shepard Niles Crane & Hoist Corp.—New, illustrated Bulletins are offered by Shepard Niles, which this year celebrates its 50th year of manufacturing overhead electric traveling cranes and hoists, both floor- and cab-operated. Bulletins 177 and 186 describe electric hoists having capacities of 1/4 to 20 tons. Bulletins 175, 176, 179, and 180 show electric cranes ranging from 1 to 450 tons.

29 TRIMMING DIES

Steel Products Engineering Co.—A 12-page Booklet describes Brehm trimming dies for flat-edge trimming and notching of drawn shells, especially engineered for single-press-stroke operation. Advantages, features, and photographs of typical trimmed products are included.

30 BOILER CLEANING

Sumco Engineering Co.—Booklet describes Sumco's entire procedure of acid washing of boilers and other heat exchange equipment. It contains technical data from a research report on the inhibitor used to protect boiler metal, and methods of control.

31 UNIFLEX HOSE

Titeflex, Inc.—A special seamless bronze tube formed into a uniform helically corrugated, flexible hose which resists vibration and corrosion. This hose is leakproof and can be used under high pressure conditions and for temperatures up to 450 F. It is made to specification in sizes ranging from 1/4 to 6 in. ID.

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32 AIR TREATMENT AND HANDLING

Westinghouse Electric Corp., Sturtevant Div.—Catalog 600 contains a 21-page equipment section, a 14-page applications section, and a 16-page engineering data section. The equipment section contains condensed specifications, dimensions, and descriptions of the Westinghouse-Sturtevant fans, heating and ventilating units, electronic air cleaners, and air-conditioning equipment. The applications section relates equipment capabilities to job requirements; the engineering data section contains numerous tables of such information as relative characteristics of centrifugal fans, average air velocities for exhaust hoods, air requirements for the combustion of oil, gas, coal, and wood, properties of saturated steam, and flow of air through an orifice.

33 BRONZE SLEEVE BEARINGS

Bunting Brass & Bronze Co.—Standard stock industrial cast bronze sleeve bearings, bronze bars, electric-motor cast bronze sleeve bearings, and graphited oilless sleeve bearings are contained in Catalog 52. There are 854 different sizes of standard stock bearings, from $^{9}/_{16}$ in. to $4^{1}/_{2}$ in. ID, and 324 different electric motor bearings, as well as 263 sizes of tubular and solid bars.

34 COOLING TOWERS

Water Cooling Equipment Co.—Recently revised illustrated Catalog describing types of cooling towers and their outstanding design features, induced-draft systems, forced-draft systems, low-head induced-draft cooling towers, and atmospheric cooling towers is now available. The factors determining selection of water cooling towers and the engineering assistance available from WCEC are fully described. Capacity tables and physical data are included.

35 AIR-COOLED ENGINE

Wisconsin Motor Corp.—Bulletin No. S-143 describes and illustrates the latest Wisconsin Heavy-Duty Air-Cooled Engine (V-type, 4-cylinder), rated from 25 hp at 1400 rpm to 36 hp at 2200 rpm. Standard engine with side-mount fuel tank and pre-cleaner is shown, also equipped with clutch assembly, and complete power unit with clutch reduction. Power curve, dimensional illustrations, and detailed specifications are included.

The Latest Industrial Literature

offered in this list represents recently issued Catalogs, Bulletins, Handbooks, Data, Booklets, Charts. Informative Folders and other engineering information made available.

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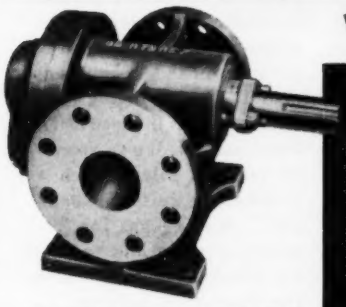

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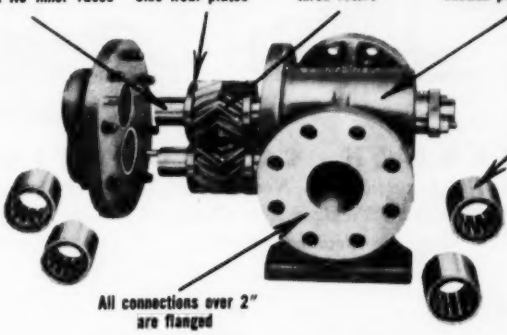

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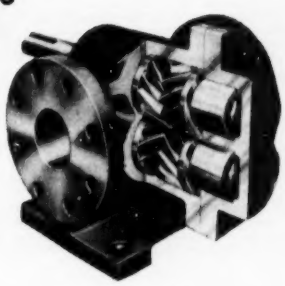

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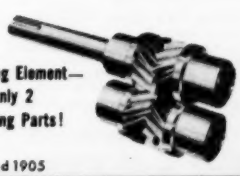

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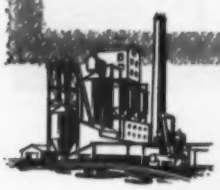

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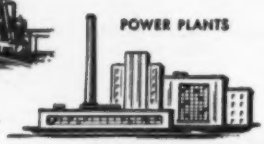

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36 STEEL VALVES

Wm. Powell Co.—Catalog No. 102 summarizes the broad line of Powell cast-steel valves. Included are bolted flanged bonnet valves, class 150 lb to class 2500 lb inclusive, and pressure seal valves, classes 600, 900, 1500, 2500 lb and higher. Containing more than 200 pages, the bulletin discusses the production facilities at Powell, the engineering service, large stocks in principal cities of the United States, vigilant laboratory control of metal heats, the chemical and physical properties of the various Powell cast steels, and specification data on each of a wide variety of valve classes.

37 DUST-CONTROL EQUIPMENT

Dracco Corp.—A new 40-page bulletin No. 800 presents complete technical information on the extensive line of Dracco dust-control equipment. Multi-Bag Filters, Uni-Filters, Dustomatic Filters, "DH" Filters, and Whirl-Clones for the control or recovery of all kinds of industrial dust are featured. Also included are explanations of operational featured, specifications in tabular form, and installation photographs.

38 DISK-TYPE ELECTRIC MOTORS

Howell Electric Motors Co.—Howell Disc-Type Motors, offering length reductions from 41.7 to 50.5 per cent under that of conventional motors of the same horsepower, depending on horsepower, are described in a new technical bulletin. Sizes range from 1/4 to 20 hp at 1800 rpm, in open or enclosed types, with a variety of designs, mountings, and frame sizes.

39 GATE VALVES

Darling Valve & Mfg. Co.—Bulletin 5006SLS covers Darling's parallel-seat, fully revolving, double-disk gate valves of cast iron, cast steel, or all bronze. Advantages and construction features are discussed and illustrated in the 4-page leaflet.

40 STEAM-JET VACUUM PUMPS

Croll-Reynolds Co., Inc.—A 19-page Catalog gives numerous illustrations and descriptive data on steam-jet vacuum pumps of the single- and multi-stage type. It also discusses steam-jet refrigeration, thermocompressors for recovering exhaust steam, and barometric condensers. Engineering data in the form of curves and charts is included.

41 WATER TANK

Chicago Bridge & Iron Co.—An 8-page pamphlet "The Watersphere" describes a modern elevated water tank of welded steel construction used to provide gravity pressure in public or private water systems. Included are a table of standard sizes from 25,000 to 250,000 gal., cross-section sketch of typical installation, and large illustrations of six installations of various capacities.

42 FANS AND BLOWERS

Chelsea Fan & Blower Co., Inc.—A 20-page Catalog No. 500 describes the comprehensive line of ventilation equipment for industry, farm, and home. Detailed specifications on all fans are included. For attic fans, recommendations for installation can be found on the respective pages. A four-page Bulletin No. 450 is available describing in detail the selection and installation of the proper fan in industry and home.

43 ROLLER BEARINGS

Shafer Bearing Co.—Engineers and specifiers of industrial roller bearings and mounted units will be interested in 56-page Catalog 51. Illustrates and describes full line of roller bearing units plus unmounted roller bearings. Design features such as concave rollers operating between matched convex races, and the advantages of this design are fully discussed. Of interest are larger models of bearing units with standard shaft sizes now available up to 5-in. diam. Also contains complete engineering and load rating data and illustrates many product applications.

44 CATALYTIC COMBUSTION

Catalytic Combustion Corp.—Reprints of three articles on vapor, odor, and fume disposal by catalytic methods have been published. "Fume Disposal by Catalytic Combustion" describes the experience of a chemical company in disposing of fumes from varnish-manufacturing kettles. "Paint Company Beats Odor and Fume Problem With Special Measures" discusses a paint manufacturer's problems and solutions concerning the processing of varnishes, resins, and oils near a residential district. "Catalytic Combustion of Hydrocarbon Vapors" attacks the problem of air pollution and was originally presented to the U.S. Technical Conference on Air Pollution.

45 LIQUID METERS

Neptune Meter Co.—New 20-page bulletin describes meters for handling over 100 industrial liquids in processing, batch mixing, cost control operations. Includes Auto-Stop meter with automatic quantity control for accurate formulas. New meter-selector charts give complete selection and specification data for over 30 different liquid meters. Capacities from 2 to 1000 gpm, temperatures to 250 F, pressures to 500 psi.

46 INDUSTRIAL FANS

New York Blower Co.—Bulletin 521 lists dimensions and performance specifications of Type G.I. industrial fans. Housing arrangements and their approximate dimensions for different sizes of fans are given, as well as engineering information and charts. A general approach to heat fan engineering is included.

47 ROLLER BEARINGS

Berliss Bearing Co.—Catalog No. 522, "Berliss Roller Bearings," contains a complete description and specifications of bearing selection for the materials handling, automotive, agricultural machinery, and transportation industries. It describes rollers, bearings, roller assemblies, cage and split outer race assemblies, together with bearing-selection data covering load speed factor, stationary shaft factor, and bearing life with shaft and housing limits.

48 SCREW CONVEYOR

Link-Belt Co.—The 92-page Book No. 2289 contains detailed engineering data on screw conveyors and screw feeders, with selection tables and horsepower formulas, layouts and arrangements, dimensional data, and installation photographs. One table lists 250 materials and classifies them by size, flowability, abrasiveness, average weight, and other characteristics.

49 ALUMINUM IMPACT EXTRUSION

Aluminum Co. of America—"Alcoa Aluminum Impact Extrusions" describes the impact extrusion process and its applications. Factors affecting design, tolerances, machining, standard diameters and sizes, and special finishes and wall thicknesses are contained in the booklet, as well as illustrations of a variety of products.

50 MEASURING AND RECORDING INSTRUMENTS

Consolidated Engineering Corp.—New general Catalog describes "Electromechanical" instrument systems for automatic measurement and recording of physical variables, such as pressure, vibration, acceleration, stress, strain, temperature, etc. Systems record up to 36 high-speed physical variables simultaneously. All instruments are described briefly and specific technical bulletins are listed on each.

51 METALWORKING MACHINES

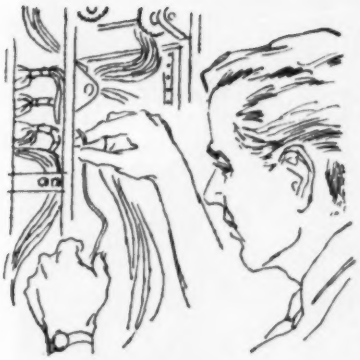
O'Neil-Irwin Mfg. Co.—New 32-page catalog describes how Di-Acro precision metalworking machines perform a wide variety of forming, cutting, and punching operations in medium and lightweight materials. Seven basic Di-Acro machines—benders, brakes, notchers, punch presses, rod parters, rollers, and shears are available in 42 hand-and power-operated models. Machine specifications and material capacities are arranged in tabular form for quick easy reference.

52 BOILER CONTROL

Continental Foundry & Machine Co., Copes-Vulcan Div.—New Bulletin No. 1007 introduces Copes-Vulcan Boiler Control with instrumentation by Taylor. A new approach to the subject is described, complete with typical schematic views including a modern graphic panel in full color.

53 WATERPROOF SWITCHES

Control Products, Inc.—Leaflets on the following waterproof switches have been published: basic waterproof switch (No. 201), single-pole single-throw toggle switch (Nos. 257, 406, 430, 447, 452, 457, 20720), single-pole double-throw toggle switch (Nos. 298, 483, 475, 477, 20558), single-throw push-button switch (Nos. 300, 445, 20600), single-pole lever-actuator switch (Nos. 450, 495, 20590, 20610, 20870), and Douglas ordnance-type waterproof single-cable and Y-connectors; in addition six pages of test results are available.



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54 ELECTRIC MOTORS

Jack & Heintz.—Folder describes custom-built electric motors for variety of uses. Motors can be specially engineered for applications requiring odd voltage or frequency, polyphase, direct current, quick reversing, special mounting, special shaft specifications, and custom painting.

55 CHAIN COUPLING

Morse Chain Co.—Catalog C 45-49 describes Morse's complete line of roller and silent chain flexible couplings with horsepower ratings, dimensions, construction, etc. Special silent and roller chain couplings are illustrated and described.

56 O-RINGS

Linear Inc.—Compact 6-page Folder contains tables of standard O-ring sizes as well as dimensional data for installation. Notes contain general recommendations on clearances, design, material, machining, and finishes for most O-ring applications. A special compound bulletin describing the latest polymers and synthetic rubbers from which O-rings can be moulded is also included.

57 AIR MOTORS

Ingersoll-Rand Co.—Form 5070 gives many uses of air motors, illustrated with photographs, with mounting dimensions and specifications. Both multi-vane and piston air motors are covered.

58 WELDING

American Welding & Mfg. Co.—Bulletin CA-50 discusses fabrication by controlled technique flash-butt welding. Illustrated are a variety of welded rings and bands and weldments. The bulletin discusses research engineering, fabrication technique, scientific inspection, and precision machining with many successful welding problems.

59 SPREADER STOKER

Detroit Stoker Co.—A forty-eight-page Catalog describes the Detroit Rotograte Stoker, a spreader stoker with continuously cleaning grates. Method of operation, typical installations including photographs, and applications are explained in the book.

60 PUMPS

Economy Pumps, Inc.—A single sheet illustrates many types of pumps manufactured. It offers a guide to those who are interested in requesting additional catalog material and engineering data.

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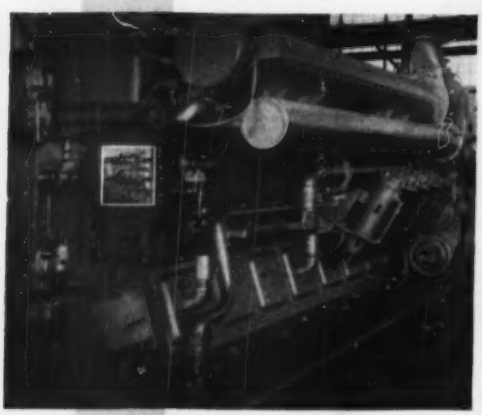
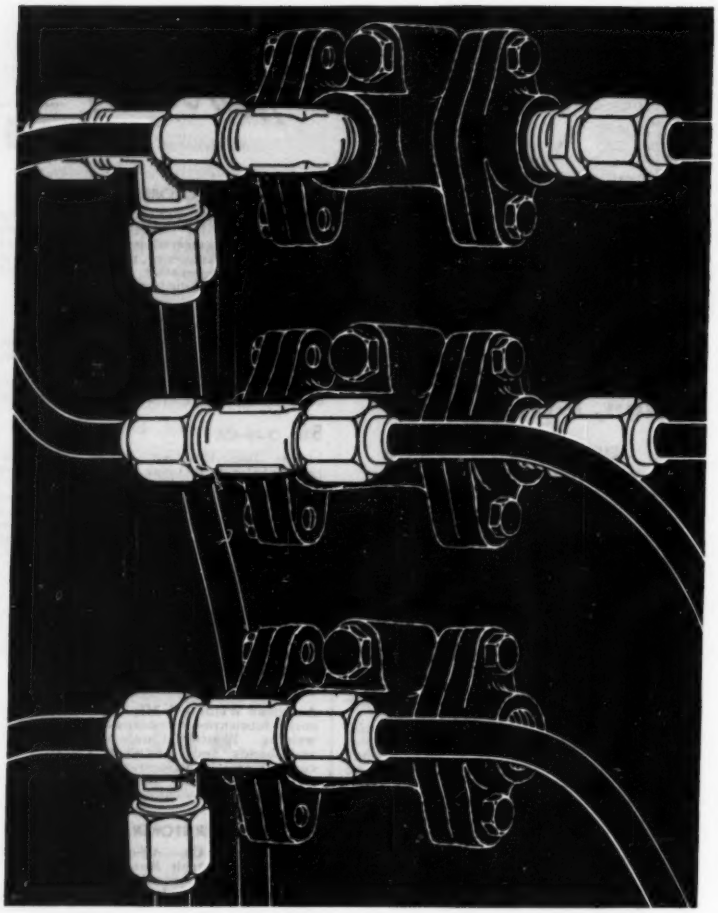
MS-9A

ON DIESEL ENGINES



This typical Diesel engine manufactured by The National Supply Company, Engine Division, Springfield, Ohio, is equipped with Parker Triple-lok Fittings.



Tube it up...Forget it...WITH PARKER

TROUBLE-FREE TRIPLE-LOK FITTINGS

Diesel service is rugged. Constant vibration puts a severe strain on all engine parts, including fittings connecting fluid handling lines. Yet no leak, however small, can be tolerated.

That's why so many Diesel engine manufacturers rely on Parker Triple-lok Fittings . . . the fitting that meets specifications of the A.S.M.E. Code for Pressure Piping, and J.I.C. and S.A.E. standards. They are leakproof under severest conditions of vibration, elevated temperatures, high pressures and repeated assembly.

So *tube it up* and *forget it* . . . with Parker Triple-lok Fittings. Ask your Parker Distributor for Tube Fitting Catalog 4300, or write The PARKER Appliance Company, 17325 Euclid Ave., Cleveland 12, O.

This does it

Triple-lok . . . 3-piece flare fitting famous for its sleeve . . . the easiest way to install tubing systems. Made in brass, steel, stainless steel, aluminum alloy.

Precision Mark of

Leakproof Tube Fittings

Parker

TUBE FITTINGS • VALVES • O-RINGS

Plants in Cleveland • Los Angeles • Eaton, Ohio • Berea, Ky.

Parker

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CINCINNATI 29, O.—Williams & Co., 3231 Fredonia Ave.
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CLEVELAND 15, O.—B. W. Rogers Co., 1900 Euclid Ave.
CLEVELAND 14, O.—Williams & Co., 3700 Perkins Ave.
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DALLAS 9, Tex.—Metal Goods Corp., 6211 Cedar Springs Rd.
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DAYTON 10, O.—J. N. Fauver Co., 1534 Keystone Ave.
DENVER 2, Colo.—Metal Goods Corp., 2425 Walnut St.
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HOUSTON 3, Tex.—Metal Goods Corp., 711 Milby St.
HOUSTON 1, Tex.—Standard Brass & Mfg. Co. 2018 Franklin St.
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JACKSONVILLE, Fla.—Florida Metals Inc. 2937 Strickland St.
KANSAS CITY 16, Mo.—Metal Goods Corp., 1300 Burlington Ave., North Kansas City
KNOXVILLE 5, Tenn.—Leinart Engineering Co. 412 E. 5th Ave.
LOS ANGELES 4, Cal.—Haskel Engineering & Supply Co. 721 W. Broadway, Glendale
LOS ANGELES 12, Cal.—Metropolitan Supply Co. 353 East 2nd St.
MEMPHIS, Tenn.—J. E. Dilworth Co., 730 South Third St.
MILWAUKEE 3, Wis.—Morman Belting & Supply Co. 522 W. State St.
MILWAUKEE 4, Wis.—Wallace Cos. of Wisconsin 838 So. 6th St.
MINNEAPOLIS 15, Minn.—Vincent Brass & Copper Co. 124 Twelfth Ave., So.
NEW ORLEANS 12, La.—Metal Goods Corp., 432 Julia St.
NEWPORT NEWS, Va.—Noland Co., 27th St. & Virginia Ave.
NEW YORK 12, N. Y.—Nielsen Hydraulic Equipment, Inc. 298 Lafayette St.
NEW YORK 14, N. Y.—Whitehead Metal Products Co. 303 West 10th St.
PHILADELPHIA 40, Pa.—Whitehead Metal Products Co. 1955 Hunting Park Ave.
PITTSBURGH 33, Pa.—Williams & Co., 901 Pennsylvania Ave.
PORTLAND 10, Ore.—Hydraulic Power Equipment Co. 2316 N. W. Savier St.
ROANOKE 10, Va.—Noland Company, 11 Salem Ave.
ROCKFORD, Ill.—Rockford Tool & Transmission Co. 802 Broadway
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SEATTLE 9, Wash.—Palmer Supply Co., 222 Westlake, N.
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ST. LOUIS 15, Mo.—Metal Goods Corp., 5239 Brown Ave.
SYRACUSE 4, N. Y.—Whitehead Metal Products Co. 207 W. Taylor St.
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TULSA, Okla.—Ardun Supply Co., 317 S. Detroit
TULSA 3, Okla.—Metal Goods Corp., 302 North Boston
CANADA—Railway & Power Engineering Corp. Ltd.
EXPORT—Mercator Corp., 438 Walnut St., Reading, Pa.

YOUR *New Catalogs* GUIDE

61 AIR MOTORS

Bellows Co.—Bulletin CL-30 describes and illustrates the Bellows air motor—the air cylinder with built-in valve and speed control regulators. Thirty pages of case history photographs, diagrams, wiring circuits, technical data and dimensional information. Brief descriptions of other Bellows "control-air-power" devices are included.

62 FASTENER PROBLEMS AND SOLUTIONS

Elastic Stop Nut Corp. of America—First printing of a 32-page collection of ESNA's "Fastener Problem of the Month" has been published. The booklet includes an illustration and description of 28 specific problems and their solutions as worked out by ESNA engineers, and is three-hole punched for insertion in reference files.

63 RETAINING RINGS

Waldes Kohinoor, Inc.—A new 52-page catalog covers Waldes Truarc retaining rings, including 28 pages of engineering and specification charts, 6 pages of field applications and case histories, 18 pages devoted to Truarc pliers, assembly, and accessory tools, and other invaluable information pertaining to the most advantageous use and selection of Truarc retaining rings.

64 DRAFT GAGES

Ellison Draft Gage Co.—Non-parallax pointers and other features of Ellison Straight-Line Bell-Type Draft Gages are described in 12-page Bulletin 122, which also describes Ellison Bell-Type dial draft gages. Various types of panel mountings are detailed.

65 FLEXIBLE SHAFT POWER DRIVES

Elliott Mfg. Co.—Catalog No. 221, describes applications of flexible shafts for power drives and heavy-duty power-drives. It gives factors which determine specifications and primary requirements in engineering flexible-shaft power drives. It lists information required by Elliott engineering service in offering solutions to power transmission problems, without cost or obligation.

66 BOILER BAFFLES

Engineer Co.—Bulletin BW 44 shows construction and application of boiler baffles to new boilers, and modernization of existing units for various furnaces and methods of firing.

67 V-BELT DRIVES

Goodyear Tire & Rubber Co., Inc.—Booklet contains simplified reference tables so that the shop mechanic, farmer, or home hobbyist who wishes to design his own drive can use Goodyear belts and standard pulleys.

68 REFRACTORIES

Harbison-Walker Refractories Co.—A new bulletin on the smooth working, super duty Silica cement for use in laying refractory silica brick. Developed especially for use with Vega super-duty silica brick. This cement contributes materially to superior furnace performance and life in such furnace applications as open-hearth, electrical-steel, heating, glass-tank, copper reverberatory, copper-refining, and nickel-refining furnaces.

69 GAGES AND INDICATORS

Ernst Water Column & Gage Co.—Bulletin 11-1-52 has been released, covering some of Ernst specialties, such as bronze, iron, and stainless steel liquid-level gages; also trycocks, illuminators, and flow indicators.

70 GEAR AND GEAR UNIT APPLICATIONS

Farrel-Birmingham Co.—First two issues of Equipment News deals specifically with the above (Nos. 39-G-523 and 40-G-524.) These 4-page bulletins describe and illustrate Farrel gears and gear units in mine hoist, oil pipe line, paper mill, and marine service. Also available are general catalogs on geared speed reducing units (No. 449) and geared speed increasing units (No. 448).

Use a CLASSIFIED ADVERTISEMENT for Quick Results

A vital message to the head of the family

Two ways you can protect your family against CANCER

. . . a check
. . . a check-up

Cancer strikes in one of every two families. Each year more than 60,000 American children under the age of eighteen lose a parent to cancer.

Yet many cancers can be cured, if discovered in time.

Every man should have a complete physical examination once a year. Women over thirty-five should have a complete physical examination twice a year.

Because of scientific advances, patients are being cured today who could not have been saved even five years ago.

The American Cancer Society asks your help in the fight against cancer. Your check today will help pay for costly research. Will help keep physicians informed of latest developments in detection and treatment. Will help pay for the training of doctors to specialize in cancer.

How soon we find cancer's cause and cure depends on how soon and how much help comes from people like you.

Invest your money today for your family's security tomorrow.

"Cancer" c/o Postmaster, (Your town)
Please send me free literature about cancer.
Enclosed is my contribution of
$_____ to the cancer crusade.
Name_____
Address_____
City_____ State_____

Cancer strikes One in Five
STRIKE BACK . . .
Give to Conquer Cancer

As a flexible seal for limit switches exposed to weathering and temperatures below —100°F, *Silastic*® works where other materials fail.

Reliability is imperative in hermetically sealed limit switches used to control such aircraft parts as landing gear, bomb bay doors, turrets and flaps. Evaluation tests conducted by Electro-Snap engineers showed that Silastic was the only material flexible enough at extremely low temperatures to serve as a diaphragm-type wobbling seal. Faultless performance for over a million test cycles plus qualification under government specifications prove the excellence of the design and the superiority of Silastic.

fig. 1 *Actuating arm of switch held in depressed position and exposed to —100°F for several hours.*

fig. 2 *Actuating arm of switch released from depressed position responds instantly, demonstrating the flexibility of the Silastic seal.*

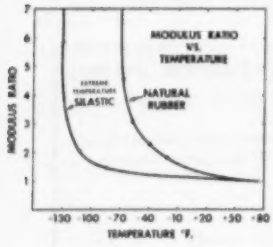
Photos courtesy Electro-Snap Switch and Manufacturing Company, Chicago, Illinois.

for superior performance specify

SILASTIC

the Dow Corning silicone rubber

Silastic stocks designed for extreme temperature applications are the only materials that will retain rubbery properties after continuous long term exposure to temperatures from —80 to 300-350°F or after repeated short term exposure to temperatures from —130° to 500°F.



As a standard for low temperature performance, we call your attention to our data[1] on modulus ratios, or relative stiffening, as measured by the Gehman test method. According to these data (see Figure) the modulus for Extreme Temperature Silastic shows no appreciable change above temperatures in the range of —112 to —130°F. Rapid change in the modulus for natural rubber and for most silicone rubber stocks takes place between —40 and —70°F.

All types of Silastic show excellent resistance to oxidation, weathering and to a variety of hot oils and chemicals. Silastic stocks for electrical applications are unique even among silicone rubbers for low water absorption and excellent dielectric properties combined with good physical strength.

Data and actual performance prove that you can count on Silastic to retain both its physical and dielectric properties after long exposure to outdoor weathering or to temperatures far above and below the limits of natural or synthetic organic rubbers.

[1] *Polmanteer et al, Ind. and Eng. Chem. Vol. 44, Page 1576, July 1952.*
**T.M. Reg. U. S. Pat. Off.*

Mail coupon today for data on the properties, performance and applications of Silastic.

Dow Corning Corporation, Dept. Q-4, Midland, Mich.

Please send me:
- ☐ Silastic Facts 10a, properties and applications of Silastic stocks and pastes.
- ☐ List of Silastic Fabricators.
- ☐ "What's A Silicone?", your new 32-page booklet on silicone products and applications.

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YOUR

New Catalogs

GUIDE

71 STEAM GENERATORS

Preferred Utilities Mfg. Corp.—Bulletin 2000 contains a description of the principal design features of the four-pass Preferred Unit Steam Generator. A complete list of standard and accessory equipment plus a table of dimensions is also included.

72 ELECTRIC BRAKES AND CLUTCHES

Warner Electric Brake & Clutch Co.—Catalog No. 6069 contains information on complete line of electric brakes and clutches for industrial application. Contains general description, torque values, and general data pertaining to all sizes. Complete capacity tables, dimensions, and specifications are included.

73 CENTRALIZED LUBRICATION SYSTEMS

Lincoln Engineering Co.—Catalog 80 describes its lubrication application equipment for centralized lubrication systems and lists the combinations of units available for various combinations of capacity and automatic and manual control and timing. Specifications of basic and accessory equipment are included.

74 OIL AND OIL-GAS BURNERS

Petro.—New 20-page catalog 3048 covers all types and sizes of Petro commercial-industrial rotary cup oil burners, combination oil-gas burners, and multi-belt-driven pumps for heavy industrial oils. Includes illustrations, descriptions, detailed construction features, wiring and piping diagrams, burner rating tables, and data on controls.

75 BOILER-WATER COLUMNS

Reliance Gauge Column Co.—New bulletin No. 516 describes boiler-water columns and gage equipment such as the original "alarm" water columns, remote reading water-level gage, liquid-level alarms, illumination equipment, gage valves, gage cocks, etc

76 SPEED REDUCERS

Western Gear Works—Bulletin 5203 describes a complete line of Pacific-Western right-angle type speed reducers. Complete engineering and selection information and specifications are provided, including a list of information desired with orders or inquiries.

77 BLOWERS, EXHAUSTERS, PUMPS, ETC.

Roots-Connersville Blower Div.—Regularly issued individual bulletins covering centrifugal blowers and exhausters; rotary positive blowers, gas pumps, liquid and vacuum pumps; positive displacement meters, and inert gas generators.

78 CENTRALIZED LUBRICATION SYSTEMS

Farval Corp.—New Bulletin No. 26 provides a complete explanation of the Farval Dualine System of Centralized Lubrication and its advantages as a means of saving oiling labor, lubricant, bearing expense, and production time for various types of heavy industrial equipment. Its 20 pages are illustrated with photographs, drawings, and diagrams.

79 SPIRAL-WOUND GASKETS

Flexitallic Gasket Co.—General Catalog gives properties, applications, construction features and advantages of Flexitallic spiral-wound gaskets. Illustrates and describes pipe flange gaskets for raised face, smooth face, male and female, tongue and groove joints. Also boiler manhole and handhole gaskets. Complete size and dimension tables. Includes gasket engineering data sheet to simplify ordering.

80 INCINERATOR STOKER

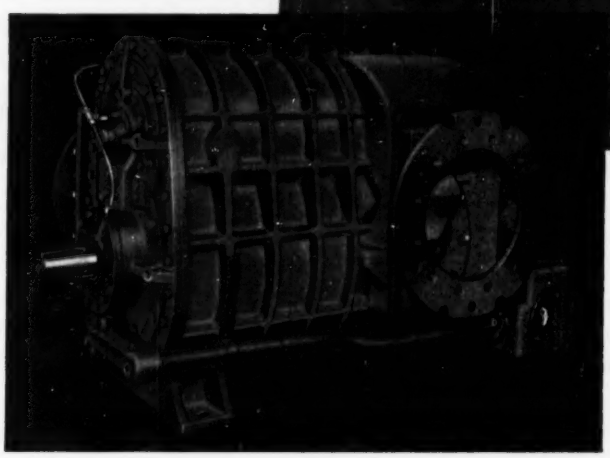
Flynn and Emrich Co.—Completely new Bulletin No. 1501 describes a new design of automatic stoker for municipal and industrial incinerators. The bulletin describes the design and operation of this incinerator stoker. Test data is included.

81 FLEXIBLE, SWIVEL, SWING, AND REVOLVING JOINTS

Barco Mfg. Co.—For piping and lines conveying steam, oil, air, gasoline, water, chemicals, including corrosive acids and alkalies, and other fluids or gases. Types for pressures up to 750 psi, steam, and 7500 psi hydraulic. Complete range of sizes. Catalogs No. 215 "Flexible Ball Joints"; No. 265 "Rotary Swivel Joints"; No. 400 "Barco Swing Joints"; No. 300 "Revolving Joints."

SHOCK

The Standardaire Axial Flow Positive Displacement Blower



Standardaire Axial Flow Positive Displacement Blowers operate on a principle of compression unlike any other blowers. Their symmetrically generated rotors act as an air screw, drawing in and discharging air smoothly from the pockets which form between them.

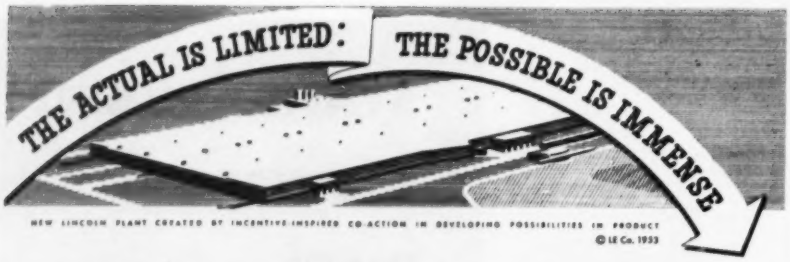
Compression is gradual, completely internal and free from shock. Internal pressure is raised to equal discharge pressure before the pocket registers with the discharge port, eliminating the slap back and loading of internal parts common to many types of blowers.

Standardaire Blowers move more air, with less wear, less maintenance and power cost than any blowers of equal weight, size or comparable design.

For further information, write:

READ STANDARD CORPORATION

BLOWER-STOKER DIVISION
370 Lexington Avenue, New York 17, New York


THE ACTUAL IS LIMITED:
THE POSSIBLE IS IMMENSE
NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT
© LE Co. 1953

DESIGN CHANGE TO STEEL CUTS WEIGHT 50%

MANY machine designs can be simplified by proper application of welded steel construction. Less material is needed since steel can be formed at low cost to efficient engineering shapes. Steel requires less machining and often eliminates such operations as milling and drilling required with conventional castings.

At Ilg Electric Ventilating Co., Chicago, Illinois, changing over this end bracket to steel provides several distinct advantages. Material cost has been cut considerably as only half as much metal is needed. Also pound for pound steel costs less than gray iron. After welding components in a simple fixture, the only machining that remains is to drill seven holes. Former milling operations are eliminated.

Although half the amount of metal is needed with steel, the part is actually stronger and more rigid than the original construction. It is easier to clean and paint and costs 30% less to produce.

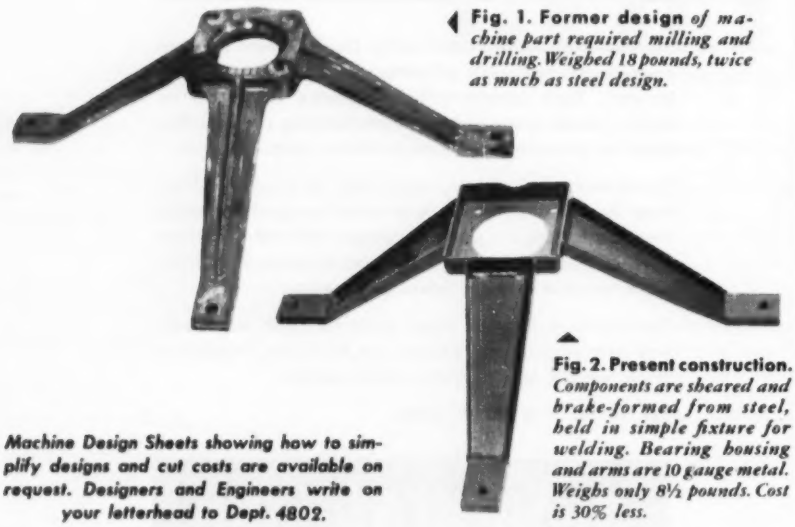


Fig. 1. Former design *of machine part required milling and drilling. Weighed 18 pounds, twice as much as steel design.*

Fig. 2. Present construction. *Components are sheared and brake-formed from steel, held in simple fixture for welding. Bearing housing and arms are 10 gauge metal. Weighs only 8½ pounds. Cost is 30% less.*

Machine Design Sheets showing how to simplify designs and cut costs are available on request. Designers and Engineers write on your letterhead to Dept. 4802.

THE LINCOLN ELECTRIC COMPANY
CLEVELAND 17, OHIO

THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

YOUR *New Catalogs* GUIDE

82 FLOW METERS

Foxboro Co.—Bulletin 460 describes basic flow meter advances and introduces six meter types for sustained accuracy in fluid flow measurement. Bulletin 465 on "Circular Case Automatic Controllers" and Bulletin 461 on "Automatic Controllers" cover other recent developments in Foxboro's line of pneumatic, electric, and electronic instruments for indicating, recording and controlling industrial process variables.

83 MINIATURE BALL BEARINGS

Miniature Precision Bearings, Inc.—New 4-page catalog, illustrated with comprehensive specifications on more than 130 types and sizes of standard miniature ball bearings from 1½ mm to ⅜ in. OD. Includes material of particular interest to designers of precision mechanisms—applications, lubrication, design variations, special bearings, etc.

84 CONVEYORS

Fuller Co.—Bulletin G-1 describes four basic types of systems for conveying dry pulverized materials, such as cement, flour, or pulverized clay. Photographs and drawings of typical applications are included. Valves, aeration units, bin level-indicators, and other accessories and parts are shown.

85 HYDRAULIC PUMPS AND MOTORS

Commercial Shearing & Stamping Co.—Performance characteristics of PD series single oil hydraulic pumps furnished in gear widths ½, ¾, 1, 1½, 2, 2½, and 3 in. are recorded in charts and tables. Horsepower input and gallonage discharge are shown through a pressure range from 0 to 1500 psi and a speed range up to 3000 rpm. Also, performance characteristics of MD series single oil hydraulic motors furnished in gear sizes 1, 1½, 2, 2½, and 3 are given in charts and tables. Gallonage input and corresponding horsepower delivery are shown through a pressure range from 0 to 1400 psi over a speed range up to 1200 rpm.

86 SWISS PRECISION MACHINE TOOLS

Carl Hirschmann Co.—General Catalog is a comprehensive illustrated reference volume on the Hirschmann Blue-Ribbon List of Swiss precision machine tools. Data included cover specifications and description of scores of precision tools manufactured in Switzerland by such firms as Agathon, Burri, Chappuis, Diametal, Dubied, Ebosa, Essa, Hauser, Hommel, Huller, Kellenberger, Kummer, Lambert, Lienhard, Manurhin, Meteor, Mipsa, Nassovia, Safag, Schaublin, Tavannes, Technica, Thommen, Tornos, and Tripet, and exclusively represented in the U.S. by Carl Hirschmann Co.

87 FRACTIONAL HORSEPOWER GEARS

Gear Specialties, Inc.—6-page bulletin illustrates and describes complete facilities together with different types and applications of G.S. small gears from 12 to 96 diametral pitch. Handy diametral pitch and circular pitch charts included.

88 BEARING MOUNTING AND REMOVAL

SKF Industries, Inc.—Bulletin 344 describes system of hydraulic removal, a bearing mounting and removal system pioneered by SKF. Using simple equipment, oil is forced between the roll neck and the bearing bore, pressure breaks the fit, the bearing slides off quickly and easily, safe from damage to bearing or equipment. Practical applications are given.

89 VIBRATION CONTROL

MB Mfg. Co., Inc.—Bulletin 1-VE describes and illustrates a complete line of vibration exciters and calibrators, vibration meters, and automatic cycling systems. Bulletin 124C describes a complete line of vibration pickups. Bulletin 410 describes a general line of equipment and isolators.

90 PACKAGED STEAM GENERATORS

Cyclotherm Div. United States Radiator Corp.—Catalog No. 52 describes and illustrates the new Cyclonic combustion flame control that reduces heating surface requirements from 5 to 3 sq ft per boiler hp and delivers a guaranteed minimum efficiency of 80%. Also lists data on Cyclotherm 2-pass generators, fiberglas insulated, from 18 to 500 hp, 15 to 200 psi operating pressure.

For Consulting Engineers Turn to Page 166

YOUR

New Catalogs GUIDE

91 PIPING FABRICATION AND ERECTION

Dravo Corp.—A 24-page illustrated booklet, bulletin No. 1700, shows piping installations in steel mills, for gas transmission systems, central power stations, water pumping stations, heating plants, oil refineries, and chemical process plants. Dravo's engineering and fabrication facilities are also illustrated and described.

92 FLAT LAPPING

Crane Packing Co.—16-page booklet, fully describes the new "Lapmaster" method of flat lapping to extremely close tolerances on an automatic, high production basis. Photographs, diagrammatic drawings, and complete data on "John Crane" Lapmaster Models "12", "24", "36", "48", and "72" provide profitable information for all industries whose manufacturing operations include finishing parts to precision surface flatness and finish.

93 STEAM GENERATORS

Union Iron Works—New General Catalog No. 153, 20 pages, contains typical installation drawings and condensed data on all types of Union Steam Generators and allied equipment. Also included is a section on Dowtherm Generators.

94 COPYING EQUIPMENT

General Aniline & Film Corp., Ozalid Div.—"Hundreds of Uses" is a new, 48-page booklet describing Ozalid's uses for engineers and businessmen. Part I explains the Ozalid copying process, materials, and uses; Part II consists of case histories showing how Ozalid is used in various departments and industries.

95 COMBINATION OIL-GAS BURNERS

Anthony Co.—New Data Sheet BG-H describes in detail the Anthony Nebulyte Combination Oil-Gas Burner, and includes a capacity table, selection chart graph, dimension drawings and typical layouts of burners and accessories. Also available are new Data Sheets BA and BD covering low- and high-range industrial oil burners and Bulletin 501 on the Anthony Proportioning Burner.

96 MOTORS AND CONTROLS

General Electric Co.—Buying information on a carefully selected group of GE fractional- and integral-horsepower motors, motor starters, control accessories, and electronic controls, is contained in a 54-page catalog. The manual graphically presents product features, dimensions, weights, and pricing information.

97 COOLING TOWER EQUIPMENT

J. F. Pritchard & Co.—Complete line of specialized equipment is covered by latest illustrated catalog No. 1.19.092B. In addition to describing medium and large mechanical draft cooling towers, atmospheric types, and small packaged models, catalog provides information on cooling-tower nozzles, fans, fan drives, air and gas-treating equipment, and air-cooled heat exchangers.

98 BALL BEARINGS

General Motors Corp., New Departure Div.—"Interchangeable Ball Bearings," 1953 edition, contains conversion tables listing all makes of ball bearings with which New Departure ball bearings will interchange. Also the booklet gives interpretation of prefix and suffix nomenclature, bearing tolerances, and comparative bearing type and series numbering systems.

99 TRACING PENCILS

American Pencil Co.—Sampler includes the new improved drawing pencil designed especially for tracings, made in 4 degrees of hardness to match tracing papers. The lead absorbs the ultraviolet light, producing sharp, clear prints.

100 ALUMINUM EXTRUDED SHAPES

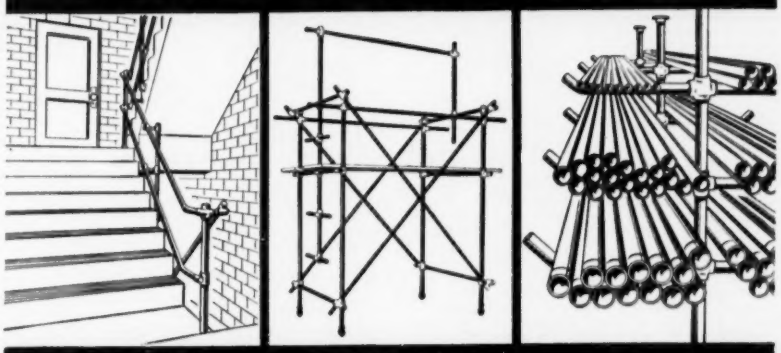
Revere Copper & Brass, Inc.—A new booklet on extruded products includes an introduction to the extrusion process and typical Revere alloys. Nomenclature and definitions are given concerning various extruded shapes together with characteristics and standard tolerances. Suggestions regarding design, and many illustrations of typical applications are included.

101 MOTOR SPEED CONTROLS

General Radio Co.—New folder describes complete line of Variac ® motor speed controls with power-handling capacities from 1/16 to 3/4 hp. Complete speed-torque curves, schematic diagrams, and various applications are depicted in detail. Dimensions, prices, and ordering information are included.

Structural Uses for ALCOA ALUMINUM PIPE

Quickly, easily assembled with Hollaender Slip-On Fittings of Alcoa Aluminum. Other types of fittings also available.



RAILINGS SCAFFOLDS RACKS

Advantages of Alcoa Aluminum Pipe:

1. **RESISTS CORROSION**—Withstands most contaminated atmospheres without painting.
2. **STRONG**—Has excellent mechanical properties.
3. **LIGHT**—Schedule 40 aluminum weighs *one-third* as much as schedule 40 steel.
4. **ECONOMICAL**—Requires little or no maintenance.
5. **BRIGHT AND CLEAN**—Modern, good-looking appearance.

Most Alcoa distributors and jobbers stock structural pipe and fittings in standard sizes, but Alcoa can supply other sizes to your specifications. Consult your local Alcoa Sales Office or write: ALUMINUM COMPANY OF AMERICA, 903-D Alcoa Bldg., Pittsburgh 19, Pa.

Alcoa Aluminum

ALUMINUM COMPANY OF AMERICA

102 CENTRIFUGAL PUMP

Goulds Pumps, Inc.—Bulletin 721.6 describes Goulds' new double-suction, single-stage, horizontally split casing centrifugal pump for general purpose use, available in 19 sizes, capacities from 200 to 6400 gpm, and heads up to 260 ft. The pump combines seven design features that mean maximum operating efficiency and minimum maintenance, and offers interchangeable parts, compact construction, easy rotation change, and the use of either conventional stuffing box or mechanical seal.

103 VAPOR-MIZER TANKS

Graver Tank & Mfg. Co., Inc.—A new 12-page booklet describes the operation of the Graver Vapor-Mizer in combating gasoline evaporation losses during storage, and covers single- and multiple-tank installations, design features, and fittings. An example based upon current API studies shows the economies possible in using a Graver Vapor-Mizer manifolded system.

104 BLOWERS

Hartzell Propeller Fan Co.—Catalog B-10 covers Hartzell belt- and direct-drive utility blowers, with ratings and principal dimensions for the various wheel diameters. Performance data for utility blowers (National Association of Fan Manufacturers Arrangement 3) and belt-drive utility blowers are included.

105 POWER TRANSMISSION EQUIPMENT

Lovejoy Flexible Coupling Co.—Illustrated Catalogs cover the following: Flexible couplings, cushions changed without shutdown, no lubrication needed, 1/4 to 2500 hp. Variable Speed Pulleys, change speed while motor is running, ratios to 3 to 1, fractional to 8 hp. Select-O-Speed Transmissions, ratios to 10 to 1, fractional to 7 1/2 hp. Universal Joints, precision-ground alloy steel, 13 sizes, bores 1/4 to 2 in., Lengths 2 to 10 3/8 in.

106 COMBUSTION EQUIPMENT

Hauck Mfg. Co.—New Catalog 52 gives a condensed and pictorial review of oil and gas combustion equipment for production, construction, and maintenance applications in industry. The catalog has 12 pages and 80 illustrations, arranged for readers' convenience.

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New Catalogs GUIDE

LATEST INDUSTRIAL LITERATURE

107 PRESSURE GAGES

Helicoid Gage Div., American Chain & Cable Co.—New 16-page Helicoid gage catalog. The Helicoid gage is the only pressure gage with the Helicoid movement. It is guaranteed accurate to within 1/2 of 1 per cent of the total dial graduation over the upper 95 per cent of the 270-deg dial arc. This means that on a 100-lb dial for example, accuracy is guaranteed to within 1/2 lb over the entire scale except from 0 to 5 lb. Cutaway photographs and line drawings show the complete line of Helicoid gages.

108 THREAD INSERTS

Heli-Coil Corp.—Design and engineering data on the complete line of Heli-Coil screw thread inserts—for the protection and repair of tapped threads in all materials—is contained in a 24-page, two-color catalog, No. 652. Covered are drilling and tapping recommendations, installation procedures, and specifications for classes, 3, 3B, 2 and 2B thread fits

109 REMOTE CONTROL

American Chain & Cable Co., Inc.—Bulletin No. DH-287 entitled "The Key to Remote Control—Tru-Lay Push-Pull Flexible Controls" describes applications of various types of push-pull remote controls for installations ranging from delicate instruments to heavy earth-moving equipment. There is a question-and-answer section pertaining to construction, efficiency, backlash, deflection, temperature ranges, and weather resistance.

110 GEARMOTORS

Westinghouse Electric Corp.—Folder B-5296 describes what to look for in a gearmotor. This includes a split housing, antifrication bearings, taper-hardened single-helical gears, adequate breather, positive oil seals, and ample lubrication.

111 SPREADER STOKER

Hoffman Combustion Engineering Co.—Catalogs 50 and 51 provide general information on spreader stokers as to available sizes, layout drawings, coal sizing data, branch offices, service facilities, etc.

112 FORK TRUCK OPERATION

Hyster Co.—A 24-page manual for use in training lift-truck operators contains information not only about the operation of a lift truck, but also preventive maintenance, safety, and basic materials handling. Drawings for setting up an obstacle course.

113 BASEBOARD HEATING

Warren Webster & Co.—Descriptive material illustrates the components of a new model of baseboard heating, introduced in January, 1953, and shows how rolled sections have been employed to reduce installation labor and number of different parts required. All data is based on using Baseboard in perimeter-heating arrangement.

114 BOILER FEEDWATER SOFTENER

Hungerford & Terry, Inc.—Bulletin BFT-1, "Boiler Feedwater Treatment," describes and illustrates zeolite and cold-process softening and partial and complete demineralization of boiler feedwater. The processes can be manually or automatically operated on any water supply for any water requirement.

115 NUCLEAR GAGES

Industrial Nucleonics Corp.—Vol. 1, No. 1, of "Nucleonics Views" describes the use of a beta gage to control automatically the weight of rubber coating given to cord and fabric used in automobile tires. Variations in weights are detected, the correction is calculated, adjustment is made, and the process is recorded on a chart, all automatically.

116 ROTARY PORTABLE COMPRESSORS

Ingersoll-Rand Co.—Four 4-page fliers, each describing one size Gyro-Flo compressor, utilize photographs, cut-away sections, diagrams, and schematic drawings. Charts show the number of tools that can be powdered by each machine. The text gives details of the rotary design and tables of weights and dimensions. Form 2314 covers the 105 cfm model; 2315-B the 210 cfm model; 2316 the 315 cfm model; and 2317 the 600 cfm model.

117 FLOWMETERS

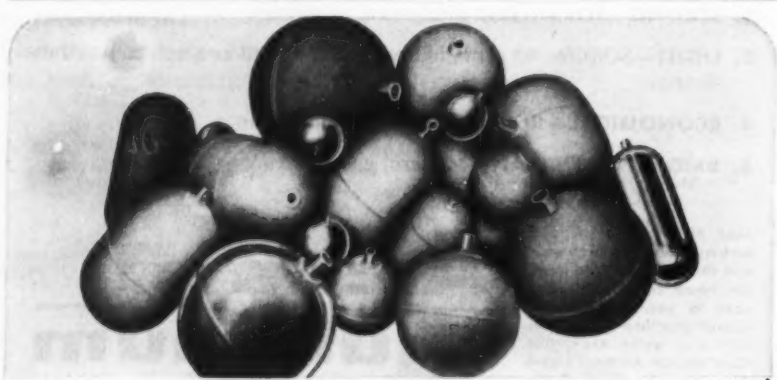
Hagan Corp.—Ring balance mechanical flowmeters are described and illustrated in detail with photographs, diagrams, and data on dimensions and capacities in bulletin 2M50. Covered is the ring balance principle of operation, which is said to be unique in that it maintains high accuracy at low flows. Among other reported features are ease of adjustment, recalibration by deadweight method or by a water column, high accuracy and elimination of over-range-operation troubles, for both low-pressure and high-pressure flowmeters of this line.

118 BAR STOCK VALVES

R-P&C Valve Div., American Chain & Cable Co., Inc.—A 16-page booklet DH-766A, describes the R-P&C line of bar stock valves. Fully illustrated, it carries dimensions and complete material specifications—including tests, working pressures, and ist prices—as well as the proper location for installing R-P&C bar stock valves.

119 DIE CASTINGS

Aluminum Co. of America—"Designing for Alcoa Die Castings" is a 190-page book on aluminum and magnesium die castings. The book covers advantages of aluminum and magnesium die castings, die-casting machines, choice of alloys, design factors and elements, machining and finishing die castings, and inspection and testing. A glossary of die-casting terms and an index complete the book.



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120 SPUN END PROCESS

Wolverine Tube Div., Calumet & Hecla, Inc.—Brochure describes the distinctive Spun End Process. In 28 pages it tells a concise story of a revolutionary metal-forming process that is highly efficient and relatively inexpensive. A quick comprehension of the process is gained through the many photographs, diagrams, and descriptions that make comparisons between old and new methods.

121 THERMAL LIQUID HEATERS

International Boiler Works Co.—Catalog describes International-LaMont Thermal Liquid Heaters designed for continuous operation at temperatures to 750 F, and constructed on the exclusive LaMont principle of forced re-circulation for high-temperature heat transfer. Units are packaged with oil or gas burners, forced-re-circulation pump, induced-draft fan, and all controls. The heaters are built in standard sizes from 250,000 to 2,000,000 Btu hr, and are also available in larger capacities (Type LFS) to 10,000,000 Btu per hr.

122 ADJUSTABLE PIPE HANGERS

Power Piping Div. of Blaw-Knox Construction Co.—New 100-page catalog 51 features the Blaw-Knox Functional spring hangers, vibration eliminators, and overhead roller assemblies. The improving and simplification of complicated piping systems is clearly explained by simple charts and specific clear line dimensional drawings. A Technical Section of the catalog enables a piping engineer to solve most hanger load problems and thus determine the hanger requirements for the particular piping under consideration.

123 MARKING TOOLS

M. E. Cunningham Co.—Bulletin J-547 describes the Cunningham line of "Safety" marking tools. It illustrates the standard line of marking devices and includes symbol charts and special codes.

124 TOOL-DIE AND SPECIALTY STEELS

Jessop Steel Co.—A 60-page catalog gives applications and working data for Jessop high-speed steels, hot-work tool steels, cold-work tool steels, shock-resisting tool steels, carbon and low-alloy tool steels, and saw steels. A section on steels for special applications is also included.

125 BELT CONVEYORS

Jeffrey Mfg. Co.—Catalog 852 shows many typical applications of Jeffrey belt conveyors. Dimensions, power requirements, capacities, and specifications are included, plus descriptions of accessory equipment. Idlers, take-ups, skirt boards, and belt cleaners are among the items listed.

126 PNEUMATIC POSITIONERS

Republic Flow Meters Co.—A 4-page bulletin is available on Pneumatic Positioning Operator which is designed for high-speed positioning and regulation. Fully described and illustrated are the high-capacity pilot valve and actuating mechanism that enables the operator to overcome starting friction and inertia. Return motion mechanism which prevents overtravel is also explained and illustrated. Bulletin contains clearance dimensions for mounting the Positioning Operator at almost any angle.

127 HEAT EXCHANGERS

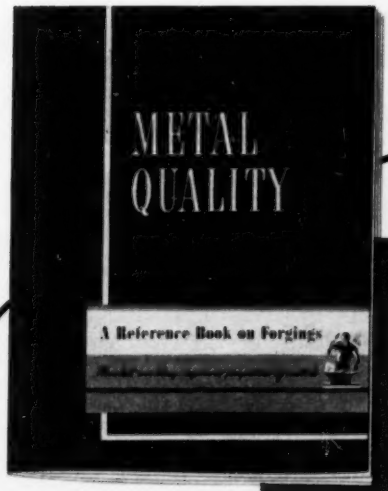
Henry Vogt Machine Co., Inc.—Bulletin HE-6 shows heat exchanger units designed for diversified applications, high-pressure services, and special operating conditions. Also included are conventional types for ordinary exchanger duty.

128 SLEEVE BEARINGS

Johnson Bronze Co.—A series of sleeve bearing data sheets discusses such subjects as powder metallurgy, lubrication, conformability, clearances, standard tests, load carrying capacity, corrosion, and alloys, and their consideration in sleeve bearings. Special sleeve bearings are included on the sheets.

129 BOILERS

Murray Iron Works Co.—Bulletin B-114 covers the Murray Type WTE Single Drum Boiler. A completely shop assembled unit, the tube headers run along the bottom of each side of the boiler, rest directly on the foundation, and the single drum is supported on the tube banks. Thus any external suspension is eliminated. The combustion space is enclosed on all four sides by water walls, and the boiler is completely insulated and enclosed in a steel casing making it a completely shop-assembled unit.



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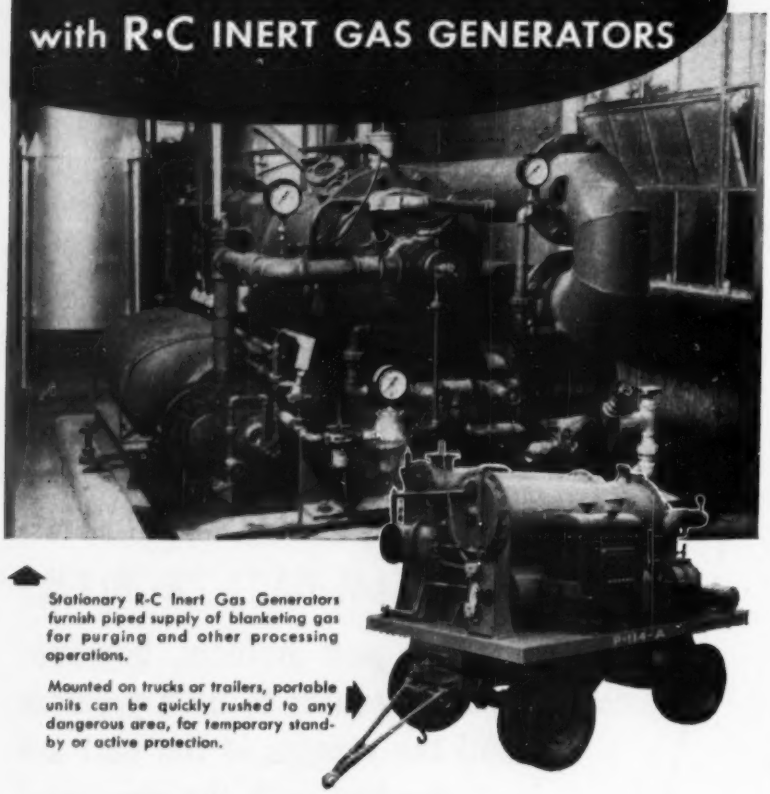

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130 HEATER PANEL OVENS

Jensen Specialties, Inc., Advance Heating Div.—Second edition of catalog "Jensen Pan-L-Heat Ovens" describes its line of heater panels and heater panel oven assemblies, with specifications and advantages. Flexibility of the heater panel oven system is emphasized, and a method for cost calculation of energy is shown.

131 THERMOSTATS

Powers Regulator Co.—New Condensed Catalog No. RB24 describes thermostatic controls for shower baths, water heaters, heating, ventilating, and air-conditioning systems. Some of the many pneumatically operated controls employed in Powers temperature control systems are shown, as well as some of their simple applications.

132 CHAINS AND SPROCKETS

Jeffrey Mfg. Co.—Catalog A418 covers Jeffrey's complete line of chains, including drive chains, drag chains, block chains, coil chains, and others, and the line of sprockets for roller chains. Tables of specifications are given. Accessory equipment and parts for units are listed.

133 DUST AND FUME COLLECTORS

Northern Blower Co.—Catalog 1002-6 describes exhaust fans for dust collecting and air handling and includes complete performance tables, test curves, etc. Plans and elevations of typical dust-collecting installations are shown. Separate additional bulletins contain descriptions, dimensions, capacities, etc. of Norblo bag type, hydraulic type, and centrifugal dust collectors.

134 ANTI-FRICTION PILLOW BLOCK

W. A. Jones Foundry & Machine Co.—Catalog 88 describes in full detail the complete line of Jones Timken-equipped pillow blocks for shaft sizes from $1^{15}/_{16}$ in. up to 9 in. in expansion and non-expansion types. Taper adaptor-sleeve principle and labyrinth grease-sealing arrangement are illustrated and described. Detailed application information including dimensions, capacities, life, and service factors are given.

135 STEAM AND LIQUID CONTROL EQUIPMENT

O. C. Keckley Co.—Catalog No. 53 contains 60 pages of illustrations and engineering data on precision pressure regulators, temperature regulators, float valves, diaphragm valves, solenoid valves, water gages, float boxes, safety and relief valves, strainers, etc. Drawings, layout diagrams, dimensions, and capacity tables are included.

136 HEAT-TRANSFER EQUIPMENT

Griscom-Russell Co.—A pictorial bulletin illustrates and concisely describes many type of heaters, coolers, condensers, and exchangers for various industries.

137 AIR HANDLING, COMFORT CONDITIONERS, COOLING TOWERS

Bush Mfg. Co.—Catalogs and bulletins containing valuable engineering and selection data. Coil catalog No. 705. Air Handling Units catalog No. 710. Cooling Tower and Evaporative Condenser catalog No. 510. Commercial Refrigeration catalog No. 350. Comfort Conditioners No. 530. Baseboard Radiation No. 565. Convectors No. 545. Finned Radiation No. 525. Covers for finned radiation No. 720.

138 SURFACE PYROMETER

Cambridge Instrument Co., Inc.—Bulletin 194SA describes three surface pyrometers for temperature determination: roll, for still or moving rolls; needle, for insertion into materials in a plastic or semi-plastic state for within-the-mass temperature determination; and mold, for checking surface temperature of mold cavities and surfaces of almost any contour.

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139 METAL CHIP CONVEYERS

National Conveyers Co., Inc.—New bulletin containing illustrations, drawings, and descriptive data of National ChipVeyor systems tells how metal turnings are crushed, conveyed, and stored and how valuable cutting oil is reclaimed for reuse.

140 PUMPS AND SEPARATORS

Kraissl Co.—A loose-leaf 8½x11-in. Catalog of its products has been published by the company. The recent additions include their new Class 23 Series air pumps designed for the printing and packaging-machinery field, which require no oil lubrication. Other data sheets describe the complete line of separators including both strainers and filters which have been listed as standard by the Board of Fire Underwriters for fuel oil service. New separator data sheets cover the Class 21 Series roller air pumps and Class 72 Series integral bronze strainers.

141 SPECIAL-PURPOSE REFRACTORIES

Carborundum Co.—A 40-page Booklet, "Super Refractories for Heat Treatment Furnaces," describes the characteristics of these refractory materials, and shows examples of how they are used in various furnaces. Among furnaces covered are artificial atmosphere, salt bath, sheet and strip annealing, car-type annealing, etc.

142 CEMENT-LINED PIPE

Centriline Corp.—Booklet describes proved method of (1) permanently increasing and maintaining carrying capacity; (2) stopping and preventing leaks; and (3) preventing discoloration of water from corrosion. Typical installations and results are described.

143 THERMOSTATIC BIMETAL

W. M. Chace Co.—New 32-page booklet entitled, "Successful Applications of Chace Thermostatic Bimetal," gives compact summary on thermostatic bimetal, contains 18 uses of bimetal as the actuating element in temperature responsive devices, and condensed engineering data for bimetal element design and selection. Illustrated with various types of thermostatic devices.

144 ELECTRIC MOTORS

Delco Motors Div.—An 8-page bulletin illustrating Delco fractional horsepower motors, Delco single-phase general-purpose motors, Delco single-phase definite-purpose motors, Delco industrial motors, and Delco polyphase industrial motors. Featured is a cutaway showing exclusive Delco features.

145 FRACTIONAL SHAFT COUPLING

John Waldron Corp., Coupling Div.—One-page brochure covering the Waldron Junior Coupling made of nylon in four hub sizes, ⅜ in., ½ in., ⅝ in., and ¾ in., each of which fit into a standard sleeve. Over 1100 in.-lb are required to break this in actual test. Advantages claimed are no lubrication, non-magnetic, non-conducting, non-corrosive, and light in weight.

146 SHIPPING CONTAINERS

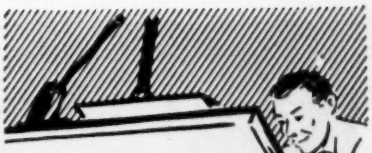
Pressed Steel Tank Co.—New catalog describes complete line of returnable-type shipping containers for liquids and solids. This includes steel, stainless steel, nickel, monel, and aluminum drums and barrels. Literature and catalog also available describing complete line of lightweight compressed gas cylinders, shapes, and shells.

147 FORK TRUCK

Clark Equipment Co., Industrial Truck Div.—No. 2, Vol. 2, of "Material Handling News", published by Clark, describes the experience of a Canadian soft-drink bottler with a fork-lift truck and pallet system. Comparative costs and advantages are discussed, with numerous photographs of Clark equipment at work.

148 VARIABLE-DELIVERY FEED PUMP

Oilgear Co.—A new 8-page Bulletin 44200 illustrates and describes their new Fluid-Power Variable-Delivery Feed Pump. Advantages claimed are simple, compact, electro-hydraulical control; easy to apply nearby or remote; quick and positive action; and automatic pressure compensation. Fine and coarse feeds are adjustable over a 20:1 range. Variable ratios from 13:1 to 256:1 are provided between feeding and rapid traverse speeds. Only two pipe lines are required.



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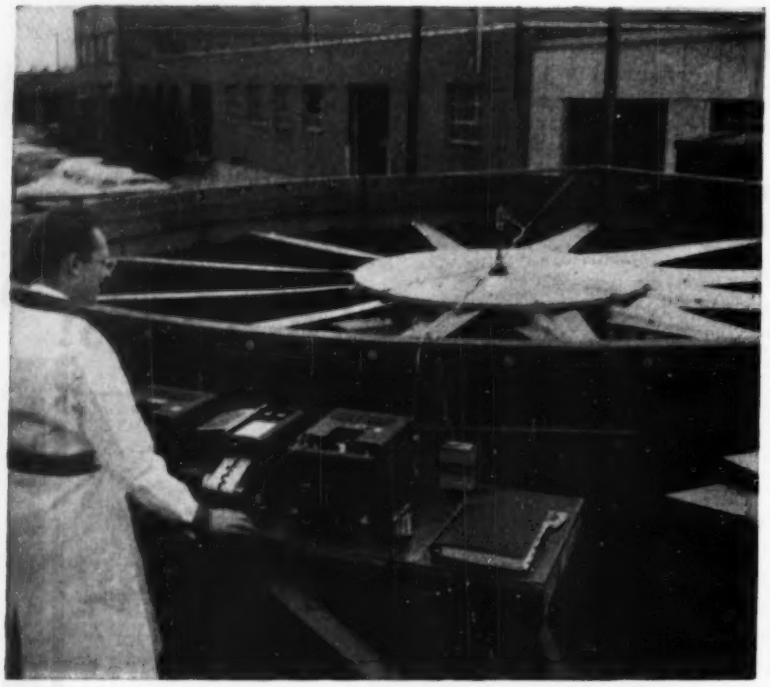

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149 BALL BEARING SWIVEL JOINTS

Chikuan Co.—Catalog No. 53-C illustrates and describes complete line of over 500 different types, styles, and sizes, with data on working pressures, maximum temperatures, dimensions, and weights. 12-page catalog No. 2A gives data on aircraft-hydraulic swivel joints for pressures from 1000 psi to 3000 psi.

150 SELF-CONTAINED BOILERS

Cleaver-Brooks Co.—Boiler Catalog No. AD-100 includes complete description of the Self-Contained LR Boilers for heating and processing. The catalog lists features, shows typical applications, covers design, construction, and efficiency, and contains charts on capacities and dimensions. Back cover contains complete list of sales representatives handling and servicing Cleaver-Brooks Self-Contained Boilers.

151 METAL BENDING

O'Neil-Irwin Mfg. Co.—New 32-page bending manual contains information on a wide variety of forming operations. The bending of tubing, angle, channel, extrusions as well as solid materials is graphically illustrated. Detailed prints show the exact manner in which any rotary-type bending machine can be tooled for precision bending. The manual outlines the recommended steps in designing parts to be formed, choice of materials, and selection of bending equipment.

152 WORM GEAR SPEED REDUCERS

Cleveland Worm and Gear Co.—Catalog 400 illustrates and describes all models in the Cleveland Worm Gear Speed Reducer line. Its 180 pages present engineering data on each type, including dimensions, weights and horsepower capacities. This information permits proper selections of drives for any kind of power-driven equipment.

153 PISTON RINGS

Koppers Co., Inc.—**Piston Ring Dept.**—16-page folder describes Koppers "American Hammered" piston rings for industrial use. Individual ring types shown with specifications for use in combustion engines, hydraulic systems, compressors, etc.

154 INSULATED PIPING SYSTEMS

Ric-Wil Co.—A 4-page Folder Form 5205 describes briefly the complete line of products: prefabricated insulated piping for underground or overhead distribution of steam, oil, hot or chilled water, process liquids; large diameter prefabricated Utilidor conduits for housing all utility services; prefabricated manholes; and various related equipment including conduit- and pipe-testing caps, insulation fittings for 90-deg elbows, unloading slings, and corrosion-resistant phenolic-resin coatings.

155 VIBRATORY MATERIALS HANDLING EQUIPMENT

Syntron Co.—Catalog No. 532, 52 pages, illustrates and describes complete line of equipment, including bin vibrators, vibratory feeders, weighing and batching feeders, long conveyers, shaft seals, and power tools.

156 PACKAGE BOILER

Combustion Engineering-Superheater, Inc.—The C-E Package Boiler, Type VP, described in catalog, is a shop-assembled steam-generating unit with such features as a fully water-cooled furnace (all walls, roof and bottom); quiet centrifugal forced-draft fan; 30-in. diam. lower drum; and a simplified baffle arrangement. The Type VP is offered in capacities from 4,000 to 30,000 lb steam per hr, and design pressures to 250 psi.

157 MECHANICAL SPRINGS

Associated Spring Corp.—"The Mainspring," the house organ of its ten Divisions is offered. It contains articles of scientific and practical interest prepared for engineers, designers, and users of mechanical springs. Published bimonthly.

158 PROGRESSING-CAVITY PUMP

Robbins & Myers, Inc., Pump Div.—Bulletin 30-C describes the Moyno Progressing-Cavity Pump. A helical rotor turning within a double-helical stator provides a gentle, positive displacement that will not break up semi-solids or aerate liquids. The pump is self-priming and will not vapor-lock or cavitate. No valves or pistons are used.

YOUR

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LATEST INDUSTRIAL LITERATURE GUIDE

159 EXPANSION JOINTS

Flexonics Corp.—A new 16-page illustrated Catalog, describing all types of Flexon corrugated expansion joints and the basic theory behind expansion joint design, gives specification and installation information for the recently redesigned Flexon line. Presented in the catalog are Flexon free-flexing expansion joints, for low-pressure applications; controlled-flexing joints, for absorbing greater amounts of traverse; and Flexoniflex integral-ring expansion joints for extremely high pressure applications. Also covered are dual, hinged, balanced, and bulkhead units.

160 ELECTRIC MOTORS

Sterling Electric Motors, Inc.—A 20-page catalog contains complete descriptive information on variable-speed drives, geared motors and constant normal speed motors in dripproof, splashproof, totally enclosed and pipe-ventilated designs.

161 PLUG NUTS

Lamson & Sessions Co.—A leaflet lists the advantages of Lamson plug nuts over other types and explains briefly how plug nuts work, with illustrations.

162 VIBRATION-FATIGUE TESTING MACHINES

All American Tool & Mfg. Co.—Improved models of All American vibration-fatigue testing machines, with tables drilled and tapped in symmetric pattern and new linkage mechanisms, are described in Bulletin 551, "How Much Vibration Will Your Product Stand?"

163 DRIVESHAFT

Morse Chain Co.—Revised 8-page Bulletin F 41–53 includes the latest dimensional data and specifications for selection of Morse Morflex Radial Driveshafts with spline-jointed tubular shafts, and Morflex Universal Driveshafts with one-piece tubular shafts or spline-jointed tubular shafts. A working table of maximum recommended lengths and speeds is included.

164 VENTILATING AND HEATING EQUIPMENT

L. J. Wing Mfg. Co.—A 4-page Brochure 6c/Wi describes unit heaters, ventilating and duct fans, motorized blowers, and their practical applications for industrial and commercial use. The description of furnace draft inducers shows their advantages in delivering maximum capacity and efficiency to boiler operation.

165 HIGH-PRESSURE PUMPS

American-Marsh Pumps, Inc.—High-pressure triplex pumps, designed for applications including processing, compressing, and hydraulic-pressure testing, are described in a 6-page illustrated folder, Bulletin 295. They are available for 600 to 5,000 psi, in capacities from 1.1 to 16.5 gpm, in direct-drive and back-geared types.

166 OIL FILTERS, STRAINERS, OILING DEVICES

Wm. W. Nugent & Co., Inc.—Seven bulletins: No. 6 illustrates and describes Nugent pressure strainers; No. 7, gravity filters; No. 7A, pressure filters; No. 8, tanks, pumps, shaft oilers; No. 14, oiling and filtering systems for turbines, paper mills, steel mills, pumps, compressors; No. 15, oiling devices; No. 16, sight feed valves, multiple oilers, flow indicators, sight overflows, and compression union fittings.

167 HIGH-SPEED MOTION-PICTURE CAMERAS

Wollensak Optical Co.—Applications, characteristics, and accessories of the Fastax, a high-speed motion-picture camera are given in a new booklet.

168 METERS AND CONTROLS

Bailey Meter Co.—A comprehensive Catalog, Bulletin 18, offers information on the complete line of meters, control equipment, and engineering services by Bailey Meter Co. It is written for engineers in power plants, public utilities, and process plants. Fifteen measured variables common to power and process operations form the index for selecting appropriate metering and control equipment. Basic specifications, illustrations, and detailed literature references are included.

169 FIBERGLAS STRUCTURAL PANELS

Resolite Corp.—A new 12-page catalog describes Resolite translucent structural panels of Fiberglas-reinforced plastic, manufactured in 8 standard colors and tints. In addition to specifications, loading, and light-transmission values, and other physical characteristics of this building material, the catalog pictures suggested structural applications with detailed drawings for home or office partitions, patio covering, building facing, industrial skylighting, toilet and shower stalls, and other practical uses.

170 MICROHONING

Micromatic Hone Corp.—A 16-page Catalog AR-121 contains a brief description of the Microhoning process and equipment, and gives specifications of

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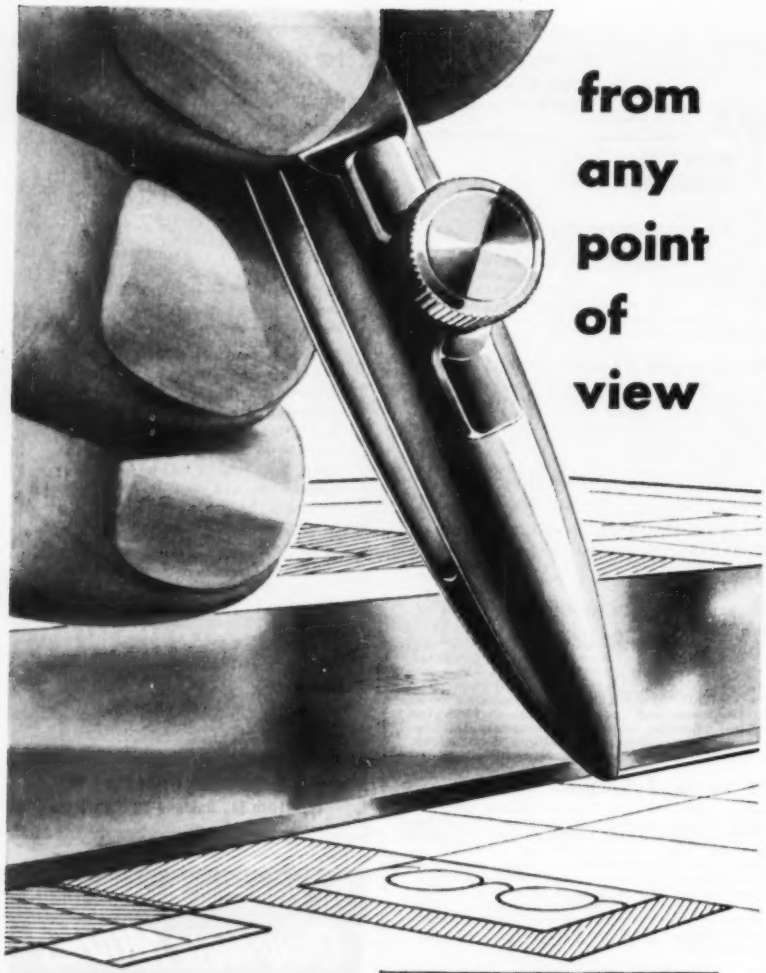

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horizontal and vertical machines, with representations of the wide range of Microhoning tools, fixtures and abrasives; also a short explanation of automatic sizing (Microsize) and automatic feed (Microdial Heads).

171 IRON CEMENTS

Smooth-On Manufacturing Co.—40-page, pocket size Smooth-On Repair Handbook describes practical, time-saving, money-saving repairs made on plant, shop, factory, garage, and home equipment with Smooth-On iron cements. Leaks stopped, cracks sealed, loose parts, and fixtures tightened. More than a million copies of this popular Manual have already been sent out in response to requests. Contains 170 diagrams. Clear tested directions.

172 PUMPS

Aldrich Pump Co.—Catalog on reciprocating pumps, 10 to 2400 hp, includes data on direct flow pumps, 3, 5, 6-in-stroke series, 10 to 900 hp (3, 5, 7, and 9 plunger units); on Aldrich-Groff controllable capacity "Powr-Savr" pumps (5 to 125 hp); and on inverted vertical pumps, up to 2400 hp, 7 in. through 8½-in-stroke sizes.

173 MARKING MACHINE

Jas. H. Matthews & Co.—The Matthews No. 204 general-purpose marking machine is described in a 4-page leaflet. Round, flat, or contoured parts can be marked using the "rolling" principle of the machine, the advantages of which are explained and illustrated.

174 BLOWERS

Lau Blower Co. Catalog 608 gives dimensional data and performance characteristics of Series single inlet blowers.

175 DRAWING-INK FOUNTAIN PEN

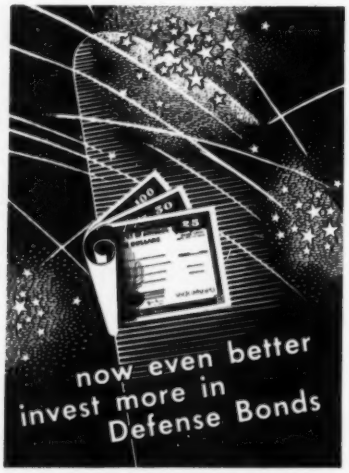
John Henschel & Co., Inc.—A Booklet describes the Pelican Graphos, a drawing-ink fountain pen with 58 interchangeable nibs. The pen will draw a uniform line from hairline thickness to ⅜ in. and is ideal for technical drawing, sketching, stenciling, and lettering. Filling time is reduced because of the ink fountain advantage.

176 CRUSHERS

Pennsylvania Crusher Co.—An attractive 12-page illustrated Handbook describes the various crushing methods and where they apply in crushing procedure. The booklet is written in a non-technical manner and contains photographs of Pennsylvania equipment. Advantages of crushing methods for the different kinds of materials and processes are discussed.

177 REVERSING VALVE STEAM ENGINES

Soulé Steam Feed Works—"Steam Feed" booklet contains full description of twin-cylinder steam engine rated 16 hp with 100 lb steam at 300 rpm. Speed and direction of operation obtained by one throttle valve. Originally sawmill carriage feed engine, suitable for any use requiring these characteristics. Many in use operated by air.



YOUR *New Catalogs* GUIDE

178 CENTRIFUGAL COMPRESSORS

American Blower Corp.—Bulletin 109 provides information on the functions, applications, ratings, and design features of single-stage centrifugal compressors.

179 WELDED STEEL TUBING FABRICATING

Armco Steel Corp.—First edition of a 24-page Booklet, "How to Fabricate Armco Welded Steel Tubing," gives general information on machines and accessories commercially available for tubing fabrication. It is useful to manufacturers who have never fabricated tubing, and also offers new cost-saving ideas to experienced tubing fabricators. Covers such subjects as cutting, deburring, bending, swaging, punching, drilling, joining, cleaning, and finishing.

180 PUNCHES AND DIES

T. H. Lewthwaite Machine Co.—New, revised Catalog sheets list the range of metal-working punches and dies carried in stock for immediate shipment. Styles to fit most makes of hand-, foot-, and power-operated punch presses are standard. Hand-operated punches, cutters, and benders are also illustrated and described.

181 FORMBRITE BRASS ALLOY

American Brass Co.—"Formbrite" is a fine-grain brass alloy described in Publication B-39, which gives some of its industrial applications and advantages. Advantages claimed for the metal are strength, hardness, springiness, and surface superior to ordinary drawing brasses.

182 VISUAL TACHOMETER

Boulin Instrument Corp.—4-page, 2-color, illustrated bulletin summarizes specific uses and advantages of measuring rotary and vibratory speeds from a distance and without contact, by means of visual hand tachometers. Cites numerous instances of use under widely different conditions in air conditioning, aircraft, automotive, chemical, oil, and textile industries.

183 HIGH-PRESSURE HYDRAULIC PUMPS

American Engineering Co.—JHP 30 Bulletin No. 3 describes a variable-discharge Hele-Shaw pump for 110-gpm delivery and operating to a pressure of 3000 psi.

184 TEMPERATURE AND PRESSURE REGULATORS

Fulton Sylphon Div.—Robertshaw Fulton Controls Co.—Well illustrated Catalog A describes the Fulton Sylphon line of regulators for temperaure and pressure control. This catalog also gives technical information relating to relief valves, pump governors, safety and vacuum regulators. In all there are over 200 pages of illustrations, data, and drawings.

185 SELF-ALIGNING COUPLINGS

Koppers Co., Inc.—Fast's Coupling Dept.—Six-page folder on Fast's self-aligning couplings gives graphic illustrations of principles and features of these couplings; table of utility factors for various kinds of connected machines; and tables of rating for standard forged-steel couplings and heavy-duty-type couplings.

186 SEPARATOR FILTERS

Jas. A. Murphy & Co., Inc.—The Murphy ASF-Aftercooler separator filter combination complete with zip trap is designed to do a complete job of cooling, cleaning, and drying compressed air before it enters the distributing lines. ASME designed and stamped, in sizes 50 to 2500 cfm.

187 BOILER-BURNER UNITS

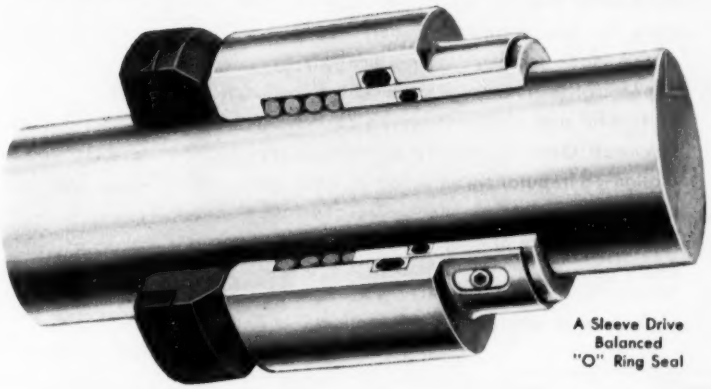
Kewanee-Ross Corp. and Iron Fireman Mfg. Co.—A 12-page illustrated Booklet describes the Kewanee-Iron Fireman boiler-burner units for high- or low-pressure heating, power, and process steam. The unit is available oil-, gas-, or combination oil-gas-fired. Features and specifications of the burner and boiler are included in the colorful booklet.

188 FORGINGS

United States Steel Corp.—A 28-page booklet, "USS Quality Forgings Fully Prepared to Do the Tougher Job", illustrates and describes the forging of generator, turbine, and waterwheel forgings, anvil bases and columns, forged shafts, forged steel rolls and sleeves, and forged blooms, billets, and rounds. The booklet closes with a brief history of forging.

Garlock "O"-Ring Seals

FOR ROTATING PUMP SHAFTS



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189 PUMPS

Detroit Harvester Co., Pioneer Pump Div.—Bulletin 160-26 describes the complete line of Pioneer and Rollway pumps. Shown are Pioneer seal and seal-less type centrifugal pumps for coolants, cutting oils, etc., with typical machine tool installations, mounting accessories, self-priming auxiliaries, and separate tank units. Rollway positive-displacement pumps handle lubricating oils and other liquids with lubricating properties.

190 TEMPERATURE AND PRESSURE INSTRUMENTS

American Machine & Metals, Inc., Gotham Instruments Div.—Catalogs No. 100 ("Industrial Thermometers"), 200 ("Dial-Type Thermometers"), 400 ("Recorders"), and 500 ("Controllers") describe industrial and dial thermometers, and temperature and pressure recorders and controllers of both pneumatic and electric types. Specifications for all instruments are given.

191 GAS-FIRED STEAM BOILERS

Mears Kane Ofeldt, Inc., Div. of S. T. Johnson Co.—Bulletin 2J illustrates and describes the Kane gas-fired automatic steam boiler which is built to ASME specification in sizes from 1 to 30 hp for steam working pressure as high as 250 lb. Boilers are compact, self-contained, completely automatic, require no attendant, and use minimum floor space.

192 AUTOMATIC CONTROLS

Mercoid Corp.—Catalog Number 700A, a 64-page reference book for engineers, contains information on automatic controls for pressure, temperature, liquid level, and mechanical movement. Transformer-relays and mercury switches are also listed.

193 RELIEF VALVES

Watts Regulator Co.—Folder FN-40 describes a complete family of temperature and pressure relief valves designed for domestic hot-water supply tanks or heaters. Valves are fully automatic, and the folder covers the entire range of relief valves needed for any size or capacity of domestic supply system.

194 STEAM TRAP PROBLEMS

V. D. Anderson Co.—Bulletin No. 151 entitled "Solving Steam Trap Problems," contains 36 pages of illustrations, drawings, and charts, describing the importance of trap selection and showing application for various industries.

195 REFRIGERATION LIQUID SEALS

Armstrong Machine Works—New four-page Bulletin 241 deals with selection and application of liquid seals to prevent high-pressure refrigerant gas from entering evaporator. Ammonia and freon charts show seal capacities and pressure drops.

196 FLEXIBLE METAL HOSE

Atlantic Metal Hose Co., Inc.—An 8-page catalog, (No. 500), provides the latest data on Atlantic flexible metal hose. Interlocking and seamless types are covered. Complete applications are given. Of value are a Navy test table for bronze and steel hose; data on bending diameters and hydrostatic bursting pressure; and a series of installation diagrams.

197 BLACK AND WHITE PRINTS

Charles Bruning Co.—An 8-page booklet "The Copyflex Process" gives a description of the diazo copying method and its applications in business and industry. Bruning's Copyflex machines and sensitized materials for every copying requirement are explained in detail.

198 TURBINE-TYPE AND CENTRIFUGAL PUMPS

Aurora Pump Co.—This 12-page condensed Catalog has illustrated descriptions of turbine-type and centrifugal pumps in various combinations of capacities, heads, suctions, and designs, for all industrial purposes including water systems. Features, construction specifications, applications, and condensed selection information are given for each pump unit.

199 WATER-TUBE BOILERS

Babcock & Wilcox Co.—Bulletin G-76A describes the Integral-Furnace Boiler, type FM, a completely shop-assembled unit available in standard sizes for loads ranging from 2900 to 28,000 lb of steam per hour, at pressures up to 235 psi. Details of design, construction, installation, and operation are discussed and illustrated.

YOUR

New Catalogs GUIDE

200 TESTING MACHINES

Baldwin-Lima-Hamilton Corp., Testing Equipment Dept.—Bulletin 4202, 4 pages, presents the FGT Baldwin-Emery SR-4 testing machine of 50,000-lb capacity for tests in tension, compression, fatigue and creep. It is a new type of universal testing machine having an electric weighing system based on the Baldwin SR-4 resistance-wire strain gage and motor-driven loading system.

201 SOOT BLOWERS

Copes-Vulcan Div.—Continental Foundry & Machine Co.—New bulletin No. 1001 offers in condensed form, pertinent data on modern automatic-sequential soot blowing systems, including control panels and descriptions of air or electrically operated rotary long and short retractable units and manually operated units. Many construction details are shown and a complete list of representatives for U.S.A. and Canada is included.

202 SPEED-MEASURING INSTRUMENTS

James G. Biddle Co.—Bulletin 35-50 describes resonant reed, centrifugal, and chronometric types of speed-measuring instruments. 28 pages devoted to the selection, operation, and illustration of Frahm, Jagabi, Jones, and Dr. Horn instruments. Also featured are repair and engineering services available.

203 SHAPED WIRE

Page Steel & Wire Div., American Chain & Cable Co., Inc.—16-page catalog DH-1226 describes how to cut production costs by the use of Page shaped wire available in low-carbon, high-carbon, and stainless steels, specially processed to meet exacting requirements for temper and physical properties, in a wide range of commercial finishes.

204 WELDED STEEL TUBING

Bundy Tubing Co.—"Bundyweld Steel Tubing" has 12 pages of descriptive material covering physical properties, standard and special tubing sizes, recommended fabrication procedures, and applications where Bundyweld has been successfully used. Information is given on fabrication services provided by Bundy.

205 LIQUID METERS

Buffalo Meter Co.—Catalog of Niagara Industrial Meters, Bulletin No. 31, describes the company's line of volumetric meters for industrial liquids including chemicals, oils, solvents, hot water, cold water, syrups, acids, and alkalis. Automatic batch-measuring equipment is described.

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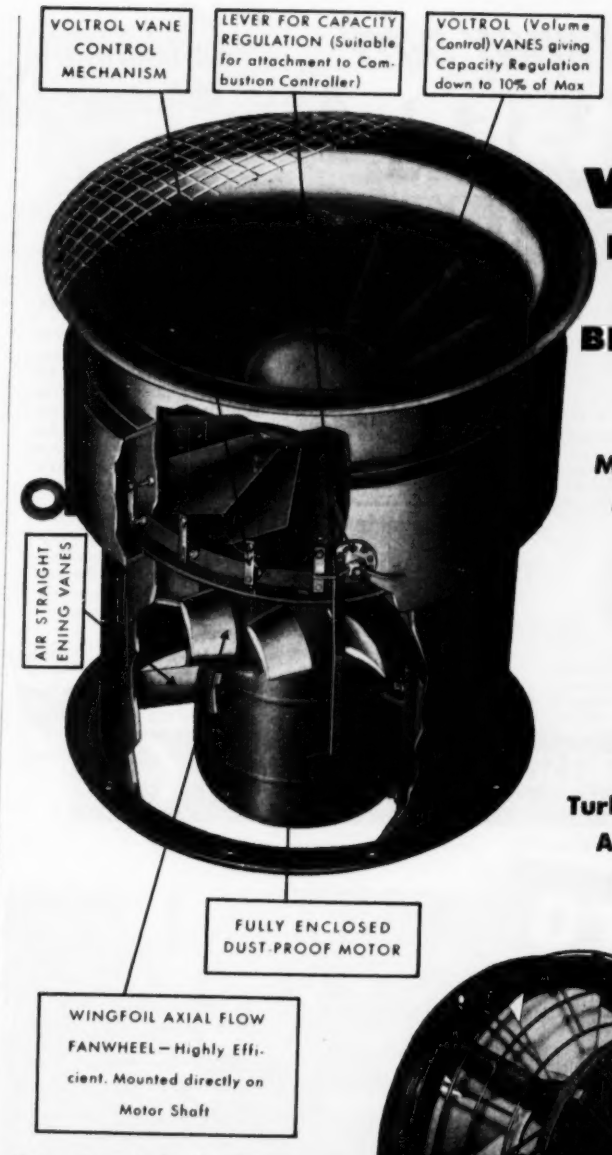
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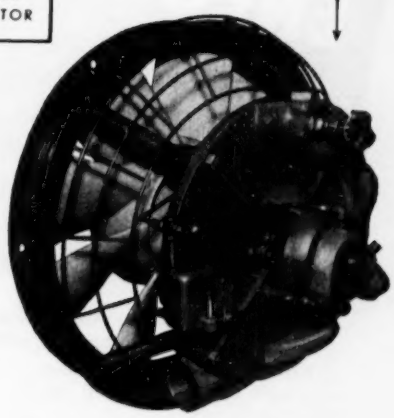
WING FORCED DRAFT BLOWERS

Type EMD Motor Driven Axial Flow Blower

Type R Turbine Driven Axial Flow Blower



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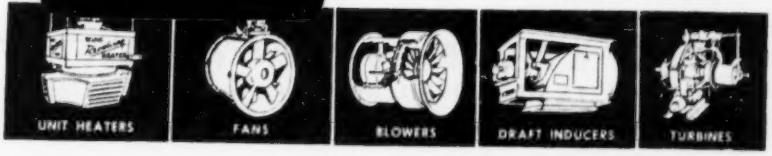

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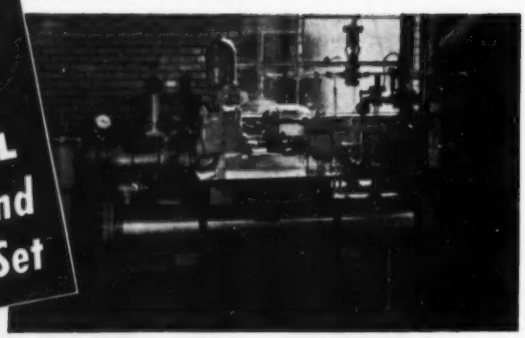

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206 PRESSURE VESSELS

Scaife Co.—Pressure vessels for air, water, and gases, are illustrated and described. Data for both horizontal and vertical types are given.

207 PULVERIZER

Kennedy Van Saun Mfg. & Eng. Corp.—Bulletin 44-C describes the Kennedy air-swept ball tube pulverizer, which does fine grinding of all materials including coal at capacities up to 50 tons per hour, availability nearly 100 percent. Moisture is evaporated in the mill during pulverization. No magnetic separator is employed and low maintenance is guaranteed.

208 ALLOY WELDING FITTINGS

Key Co.—Bulletin K.S. describes and pictures a new line of alloy welding fittings, which incorporate greater wall thickness throughout for increased structural strength and extra thickness at critical areas for greater allowance against erosion and corrosion. Advantages of this principle for alloy piping systems are explained graphically and alloys which will be available are listed.

209 STEAM-GENERATING EQUIPMENT

Kewanee-Ross Corp.—New 32-page Kewanee General Catalog 80 gives full description and complete data on entire line of boilers, boiler-burner units, and other equipment for heating, power, or process steam. It includes diagrams of small residential types up to large industrial sizes of 304 hp, for steam or water, high or low pressure, mechanically-fired.

210 PIPING DATA

Taylor Forge & Pipe Works—An 8½ × 11-in. varnished card covering wall thicknesses and essential dimensions for the Weldell line of welding fittings on one side, and essential dimensions and bolting data for forged steel flanges on the other, has been prepared by Taylor Forge & Pipe Works.

211 RADIAL-THRUST ROLLER BEARINGS

Shafer Bearing Corp.—Latest 56-page catalog gives complete specifications of Shafer ConCaVex radial-thrust roller bearings, featuring full capacity self-alignment within the bearing itself. Available in unmounted single and double-row style, or in double-row mounted units as follows: Pillow blocks, flane units, cartridge units, flange-cartridge units, duplex units, take-up units, take-up and frame units. Mounted units available in normal duty, standard heavy duty, and adapter mounting types as well as in "Specials."

212 LUBRICATION

Fiske Bros. Refining Co., Lubriplate Div.—The 56-page 1953 edition of Lubriplate Data Book contains much information in connection with improving machine operation and reduction of maintenance costs through specialized lubrication.

213 FAN EQUIPMENT

Clarage Fan Co.—New Service Manual shows how to properly install, operate, and maintain Clarage fans, blowers, and air conditioning units. Manual contains 68 pages of useful information, valuable to any engineer or maintenance man who has fan problems.

214 SOLENOID VALVES

Waterman Engineering Co.—A new illustrated booklet describes with photos and diagrams several new and improved high-pressure solenoid valves—showing their construction and their typical application. They are especially suitable for all hydraulic systems handling noncorrosive fluids.

215 ELEVATORS

Otis Elevator Co.—The 1953 general Catalog, "Vertical Transportation by Otis," describes the complete line of Otis equipment and services, including sections on passenger and hospital elevators, escalators, dumbwaiters, and freight elevators, elevator modernization and maintenance programs. Thirty-six photographs and line drawings illustrate the 24-page booklet and 17 tables provide dimensions and engineering data. Modern systems of automatic elevator control are described including the "Autotronic" system which applies electronics to handle heavy elevator traffic without attendants.

YOUR

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LATEST INDUSTRIAL LITERATURE GUIDE

216 FLOW SIGNAL TRANSMITTER

Hagan Corp.—The Hagan flow signal transmitter is described in a new bulletin, No. 2551. This pneumatically operated pressure-differential measuring unit transmits proportional signals to remote recording or indicating instruments, or to automatic control elements. The signals may be linear with flow or linear with pressure differential. Diagrams in the bulletin illustrate seven suggested uses of the transmitter in measurement of flow, liquid fuel, liquid level, and absolute pressure. Flow applications include measurement of steam output from a boiler, superheater or evaporator; of feedwater flow to a boiler; of liquid flow through pump units; and of gas, vapor, or liquid flow in process systems.

217 ROTARY POSITIVE PUMPS

Leiman Bros., Inc.—Catalog No. 752 covers rotary positive air and vacuum pumps. The catalog details construction and operational features of Leiman's four-wing and two-wing pumps, designed for applications requiring up to 29.9 in. vacuum and 25 psi. Tables of vacuum, pressure and specifications are given for each type of pump. Also included are Leiman air motors and accessories.

218 VENTILATING FANS

Propellair Div. of Robbins & Meyers, Inc.—Latest catalog, Form 3238, describes uses of various types of Propellair ventilating fans such as tubeaxial, vaneaxial, Sky-Blast, belt-driven, pulley-driven, etc. Typical modern industrial applications of Propellair equipment are pictured.

219 MANOMETERS

Trimount Instrument Co.—Bulletin on Red Line manometers illustrates well-type manometers, absolute pressure manometers, U-tube manometers, indicating flowmeters, orifice flanges, and plates.

FOR TESTING Screws, thread-cutting and thread-forming screws—all types of threaded fasteners; threaded parts and threaded connections.

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LABORATORIES and for
PRODUCT CONTROL
in assembly.

Capacities: (0-200 in. lbs.) or (0-150 ft. lbs.)

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220 BOILER WATER TREATMENT

E. F. Drew & Co., Inc.—Difficulties caused through industrial water contamination are outlined in a 12-page Catalog. Recommended water-conditioning treatments for scale, sludge, corrosion, carryover, and other boiler conditions, and efficient control methods are described. Details on a system of complete boiler water conditioning are fully explained.

221 ELECTRIC HOISTS

American Chain & Cable Co., Inc., Wright Hoist Div.—A 68-page Catalog, E-50A, lists the line of Wright Speedway Electric Hoists, in capacities up to 10 tons and lifts up to 152 ft. Complete clearance data and specifications are presented, including list prices. Ordering procedure is also given.

222 FLEXIBLE SHAFTING

F. W. Stewart Mfg. Corp.—Bulletin "Flexible Shaft Assemblies," describes new power drive circle Ess flexible shafting. Greater opportunity for diversified streamlined power transmission is offered for use in all types of metal, plastics, porcelain, or woodwork. They can be applied in hundreds of finished operations. Three types of power drive flexible shafts are presented—for heavy, medium, and light duty in commercial or industrial work.

223 FULLY CROWNED GEAR TEETH

American Flexible Coupling Co.—Seven major engineering advantages of fully crowned teeth in gear-type flexible couplings are described in a new Bulletin No. 1052. Excessive offset or angular misalignment, space limitation, high speeds, and torque loads are problems described and illustrated.

224 WATER PROBLEMS

Hall Laboratories, Inc.—Industrial water problems of all kinds—procurement, treatment, usage, and disposal—and the facilities and services offered in coping with them are described and charted in a new booklet. It points up the importance of water in all kinds of industries and industrial operations.

225 AUTOMATIC BAGGING AND PROPORTIONING SCALES

Richardson Scale Co.—Bulletin No. 0450 describes complete line of automatic bagging scales, packers, proportioning scales, process control panels, remote weight-setting equipment, continuous weighers, compounding bins, and list of over 200 materials handled.

226 HEATERS AND HEAT-TREATING FURNACES

Surface Combustion Corp.—" 'Surface' Heating and Heat-Treating Furnaces for Defense Production" lists applications of heating and heat-treating furnaces in the manufacture of ammunition and guns, engine and power-transmission equipment, tools and parts, tanks, airplanes, and ships.

227 CHANGE SPEED UNITS

Philadelphia Gear Works, Inc.—Catalog CSU-52 illustrates and describes Philadelphia change-speed units. These Herringbone gear drives are available in 2, 3, and 4-speed combinations in a complete range of sizes as speed reducers, increasers, or combination of both. Philadelphia change-speed units are widely used in wire-drawing machines and chemical mixing where exact output speeds are essential.

228 MATERIALS HANDLING

Fairfield Engineering Co.—Catalog 151, a technical 250-page catalog contains complete specifications, illustrations, and engineering data covering the many hundreds of products manufactured by Fairfield for various industry conveying, storing, and feeding applications in handling materials. The equipment cataloged includes bucket elevators, skip hoists, belt flight and screw conveyers, feeders, crushers, portable conveyers, tile storage silos.

229 CELLULAR RUBBER

Sponge Rubber Products Co.—Properties of and test data on cellular rubber are described in a 20-page explanation of grades, compression, influence of heat and aging, flexing, tensile and elongation, insulation value, special purpose stocks and specifications for open-cell and soft and hard closed-cell rubber.

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230 STEAM TURBINES

Terry Steam Turbine Co.—Bulletins in looseleaf form which cover a complete description of Terry solid wheel turbines with cross section drawings of typical units for both moderate and high steam pressure conditions: a description of the Terry axial flow impulse, both single stage and multi-stage; Terry gears which are used for speed increasing and speed reducing.

231 TECHNICAL BOOKS

The American Society of Mechanical Engineers—1953 Catalog of ASME Publications. A 20-page descriptive price list of current books, standards codes, research reports, and periodicals published by the Society.

232 SHAFT-MOUNTED SPEED REDUCERS

American Pulley Co.—New "Shaft-King" shaft-mounted speed-reduction units are illustrated and described in a 20-page speed-reduction drive Catalog. Complete information is included on dimensions of units, where they are used, and how they are installed, with instructions on how to select the correct size unit for a given application.

233 DUST COLLECTORS

Prat-Daniel Corp.—An 8-page Catalog has been published illustrating and describing the Company's Design 4P collectors. Contents include a discussion of the problems of fly-ash collection and the Design 4P tubular collector. Efficiency curves, arrangements, and standard dimensions are given. Flue-gas density tables are included with a formula and nomograph for calculating the number of tubes required for any volume and resistance.

234 BORING AND TURNING MACHINES

American Steel Foundries, King Machine Tool Div.—New 2-color catalogs, fully illustrated, containing complete description and specifications on King vertical boring and turning machines. Catalog K-1 covers machine sizes 30, 36, and 42 in.; Catalog K-2, sizes 52, 62, and 72 in.; Catalog K-3, sizes 84 and 100 in.; Catalog K-4, sizes 120 and 144 in.

235 HEAT TRANSFER SYSTEMS

Hynes Electric Heating Div., Rodman H. Martin Co.—8-page bulletin No. 102 with illustrations, engineering data, dimensions, and descriptions of electric high velocity fluid heat-transfer systems at temperatures up to 650 F. Included are design features for piping, valves, pumps, controls and related auxiliaries, as well as operating instructions.

236 TECHNICAL BOOKS

Lefax Publishers—Over 2000 listings of Lefax pocket-size technical books are contained in the newly revised 1953 Lefax list of technical data sheets. Condensed, mathematically accurate source materials for engineers, construction men, technical workers, and technical students. Each book consists of approximately 140 pages of easily read tables and data in pocket-size, loose-leaf form for handy reference right on the job.

237 CHECK VALVE

Waterman Engineering Co.—A new check valve for use in oil, air, and water, with working pressures to 3000 psi, and featuring one-piece aluminum-body construction with a nylon poppet, is described in an illustrated Circular. This check valve is available in $\frac{1}{8}$ in., $\frac{1}{2}$ in., $\frac{3}{4}$ in., and 1 in. pipe sizes.

238 FLEXIBLE METAL HOSE

Flexonics Corp.—A 32-page illustrated Catalog CMH-130 on all types of Chicago Metal Hose covers the full range of the company's Rex-Weld corrugated flexible metal hose, Rex-Tube convoluted-hose types, and Rex-Flex stainless-steel flexible metal hose. Complete specification data are given. Also covered are coupling types, special assemblies, and installation information.

239 V-BELT DRIVES

Allis-Chalmers Mfg. Co.—Bulletin 20B6051N carries the procedure for figuring "Texrope" V-belt drives by means of tables, together with examples of how to use the engineering information given. The bulletin also describes "Texrope" belts, sheaves, and speed changers.

240 LOW-PRESSURE HEATING BOILERS

Fitzgibbons Boiler Co., Inc.—A comprehensive 12-page Catalog contains full specifications and dimensional data of the entire Fitzgibbons line of low-pressure steel heating-boilers. It covers the "D" Type for both mechanical and hand firing, Scotch Type, "R-Z-U" Junior, "80" Series, "400" Series, and all Fitzgibbons Tanksaver and Tank-heater hot-water coils.

241 O-RINGS

National Motor Bearing Co., Inc.—New National O-Ring Catalog designed for broadest usefulness in all types of O-Ring applications. Includes practical working information about O-Ring applications, sizes, groove dimensions, back-up rings, and dust seals, and lists all National O-Rings and local National Motor Bearing offices.

242 TUBE CLEANERS, EXPANDERS, AND INSERTS

Thomas C. Wilson, Inc.—A comprehensive Catalog 76-A, of 48-pages, shows a full line of mechanical tube-cleaners for the cleaning of fouled boiler, evaporator, and condenser tubes. Bulletin 380-A is also available depicting a line of Wilson tube-expanders for all tubular assembly purposes. For the salvage of eroded or corroded heat exchanger or condenser tube ends, Wilson condenser tube inserts have just been marketed. Bulletin 500 describes this new item completely.

243 WELDING

Lincoln Electric Co.—"Elements of Weldesign" is a series of pamphlets issued periodically to design engineers, production men, and management executives. Current series outlines fundamentals of how to design with steel, how to reduce costs, and steel design fundamentals with special charts and checking information.

244 SILENCER

Burgess-Manning Co.—"Bring Your Plant Up to Date with Burgess-Manning Heavy-Duty Slug Buster Snubber" describes features and applications of the SDG Snubber designed for use in petroleum, chemical, and other industrial fields. This Snubber is designed to reduce noise from engines and vacuum pumps to the required noise level.

245 PRESSURE REGULATORS

Chaplin-Fulton Manufacturing Co.—Bulletin 46 describes Model 46 pressure regulator. Two new features are used in this design: The O-Ring to replace the stuffing box, and the "Dynaknob" to improve the degree of accuracy in outlet pressure control.

246 GAS-FIRED FUEL-OIL HEATER

Davis Engineering Corp.—Bulletin 60-L describes the Type GF Indirect Gas-Fired Fuel-Oil Heater, a combination steam-generator and vertically mounted steam oil-heater for use with No. 6 fuel oil systems. An automatically controlled gas flame generates low-pressure steam in the lower section. Steam passes in a closed circuit to the upper oil-heating section, and condensed steam returns by gravity to the lower section. Gas flame is not in contact with oil tubes. The heater provides quick starts for plants operating on weekend shutdowns, and enables use of No. 6 oil on processes where no steam boiler is available for oil preheating. It operates on any type of gas.

247 HYDRAULIC FLOW CONTROL

Denison Engineering Co.—Bulletins V F C give complete data on a new flow control that provides full-scale regulation of adjustable-speed circuits regardless of pump delivery, and optional range of min.-max. adjustment to 3000 psi without changing spools. Two- and 3-port types are listed for 0 to 28 gpm and in sizes $\frac{1}{4}$ in., $\frac{3}{8}$ in., and $\frac{3}{4}$ in.

248 PIPING DESIGN

Power Piping Div. of Blaw-Knox Construction Co.—The design of piping for flexibility with Flex-Anal Charts is covered in an 86-page book. It fills the need for the flexibility analysis of any piping system. It is intended for the experienced pipe designer who can, by use of this method and the application of Flex-Anal Charts, accurately analyze most piping systems in a few hours which formerly required days and even weeks. Many tables, Flex-Anal Charts, and typical piping layouts are included.

249 GRATING-FLOORING AND TREADS

Irving Subway Grating Co., Inc.—Catalog F-225 contains illustrations, descriptions and engineering data on grating-flooring, treads and floor armoring (riveted, press-locked, welded types)—safe, durable, fireproof, ventilating, clean and economical—for industrial, power and refinery walkways, stairways, driveways, trucking aisles; ship cat-walks and engine room floors and treads; locomotive, freight and passenger car runways and treads; roadway armoring expansion joints, catch basin covers, bridge decking.

YOUR

New Catalogs GUIDE

250 SOLENOID VALVES

Ruggles-Klingemann Mfg. Co.—Additional pages for catalog E on electrically operated valves now being printed showing new designs and typical applications. This catalog contains complete information for valves from 1/4 to 12 in.

251 ELECTRIC MOTORS

Allis-Chalmers Mfg. Co.—Catalog 51B6052P is designed to help determine the electrical and mechanical characteristics desired in commonly used motors and to indicate availability of less frequently used types and larger motors that may solve more involved application problems.

252 ROTARY STEAM JOINTS

Seamlex Co., Inc.—New Bulletin 5500 describes "Seamlex" rotary joints with triple protection against leakage. Principal features: External screw adjustment to compensate for wear of seal without removal of joint; floating rotary seal balances misalignments; pressure-equalizing chamber prevents excessive wear of rotary seal. Conveys liquids and gases. Made in syphon and through-flow type. Pipe sizes 1/2 to 1 1/2 in.

253 THERMOMETERS

Weston Electrical Instrument Corp.—Circular T-13 describes and illustrates a complete line of all-metal thermometers. These thermometers, operating on the bi-metal principle, are available in a variety of ranges, sizes, and types for the usual industrial and laboratory applications, as well as for alarm and control systems, maximum-minimum indicating, per cent relative humidity, etc.

254 MONORAIL APPLICATIONS

American MonoRail Co.—File F-1 offers the first of a new series of case-study sheets illustrating a group of successful MonoRail applications to widely varied handling problems. The company intends to forward sets of any new study as it is completed to all holders of the file.

255 SILICONES

Dow Corning Corp.—A Reference Guide to Dow Corning Silicone Products is a new general catalog which lists over 50 different Dow Corning Silicones according to their physical form and applications. Important properties for each product and code numbers for obtaining more information about any particular product are presented in this 4-page bulletin.

256 HYDRAULIC VANE PUMP

Denison Engineering Co.—Bulletin P-5 fully describes new Pump/Motor, which is usable as either pump or motor without alterations of any kind. Designed for use up to 2000 psi, the Pump/Motor is completely radially balanced. Interchangeable cam rings offer eleven different pumping capacities from 2.7 to 70 gpm, plus motor torque ratings from 13 to 257 in.-lb per 100 psi.

257 NONABSORBENT INSULATION

Insul-Mastic Corp. of America.—32-page catalog describes a protective coating and insulation combined. It is spray applied in coating form 1/4 in. thick. It stops 65% of heat loss or controls condensation. Prevents corrosion by repelling moisture. Temperature range −40 F to 300 F.

258 SHADED POLE MOTORS

Fasco Industries, Inc.—Catalog describes full line of shaded pole motors of the 2, 4, and 6 pole types, ranging from 1/400 to 1/3 hp. Dimensions, electrical characteristics, and curves are included. All motors manufactured are suited for use on either 110 or 220 volt, 50 or 60 cycle, current.

259 AUTOMATIC ENGINE STOP-VALVE

Golden-Anderson Valve Specialty Co.—A new 6-page Bulletin S-3 describes the Golden-Anderson "cushioned" automatic engine stop-valve. Featured in this bulletin are the application, fabrication, installation, and design, along with a complete parts list, dimensions for all sizes, and complete specifications.

260 CORROSION-RESISTANT FASTENERS

H. M. Harper Co.—Corrosion-resistant fastenings designed to meet any requirement are listed and illustrated in Catalog 25. Current prices, sizes, and shipping data are included for bolts, nuts, screws, washers, rivets, and cotter pins of nonferrous metals and all stainless steels.

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261 AUTOMATIC PNEUMATIC-TUBE SWITCH SYSTEM

Lamson Corp.—Bulletin A-101-52 explains how Automatic Switch Systems differ from other automatic systems and conventional systems, and explains in detail the fully automatic Pneumatic-Tube Switch System for transporting messages, purchase cards, small tools, laboratory samples, or other small articles from one point to any other.

262 ELECTRICAL PRODUCTS

Reliance Electric & Engineering Co.—A 4-page, quick-reference Bulletin A-2703 gives capsule digests of Reliance Precision-Built a-c motors from 3/4 to 300 hp; heavy-duty Type "T" d-c motors from 3/4 to 1000 hp.; the all-electric Reliance adjustable-speed (V-S) drive for a-c circuits, from 1/4 to 300 hp.; electronic controls and regulators for this motor-drive system; and Reliance motor-generator sets, generators, and rotating-type regulators. Many functions and advantages of each product are included, service applications for which they are designed are indicated, and representative units illustrated.

263 PACKAGE WATER TUBE BOILER

Titusville Iron Works Co.—Detailed in a new 6-page Bulletin B-3275 is the Titusville WTP Water-Tube Steam Generator. The unit is shop-assembled and shipped as a complete package with all components installed. Adapted for firing with oil, gas, and combination oil and gas, the WTP Generator is built in sizes from 7500 to 27,500 lb of steam per hr.

264 TORQUE-TESTING FIXTURE

P. A. Sturtevant Co.—A new torque-testing fixture for making ultimate-torsional-strength tests, open-hole torque tests, and driving and stripping tests of various types of screws is described in Bulletin TTF-53. Applications, such as checking strength and thread-cutting ability of taps, and strength of screw-driver bits and socket wrenches, and complete specifications are given. Special-application testing fixtures, SPT Model Push-Off Fixture, SPT Model Sensitive Compression Tester, SPT Model Hair-Spring Torsion Tester, etc., are included in the bulletin.

265 CAST STEEL VALVES

Edward Valves, Inc.—A new 56-page Catalog covers their cast steel valves, with complete information on globe, angle, and check valves in 300-, 600-, 900-, and 1500-lb pressure classes. Parabolic disk valves for hand or motor control of volume are also described in detail. In addition to the standard information on construction features, dimensions, weights, etc., the new booklet contains information on material specifications, preparation of welding ends, flange facings, pressure-temperature ratings, and other technical data required for valve selection.

266 COOLANT PUMPS

Ruthman Machinery Co.—General information outstanding features, pipe friction chart, and cross-section prints of Gusher coolant pumps are given in a 66-page catalog. Covered are immersed-type, pipe-connected type, flange-mounted external-discharge type, and flange-mounted internal-discharge type motor-drive pumps. Shaft and pulley-driven pumps and mounting brackets and tanks are also included.

267 DIES AND CUTTING TOOLS

General Electric Co., Carboloy Dept.—A new die Catalog, D-130, has a complete description of standard and special wire-, bar-, and tube-drawing dies. A tool manual, GT-191, gives "how-to" information on use of tungsten-carbide cutting tools. A general tool catalog, GT-250, offers complete information on Carboloy's cutting tool line. Additional catalogs are available on other Carboloy products, such as coal mining tools.

268 NOZZLES AND MANWAYS

Lenape Hydraulic Pressing & Forging Co.—A wide variety of circular flanged connections and access openings, oval and elliptical manway frames, covers and quick-opening devices are described in Bulletin 534 and complete Catalog 9-49. The Lenape-Lacy boltless quick-opening manway is described in Bulletin 523. Thrust-motor or booster nozzles, roll-forged or pierced rings, and circular custom weldments are among the items covered in Catalog 9-49.

269 TEST BOILERS

Besler Corp.—Test boiler bulletin, illustrated with photographs, drawings, and diagrams describes Besler high-temperature, high-pressure boilers. Designed by test engineers, these boilers are sectional, an innovation offering maximum flexibility, utmost weight and space conservation, and high efficiency. Bulletin contains specifications on 14 models with a range of capacities heretofore impossible to attain.

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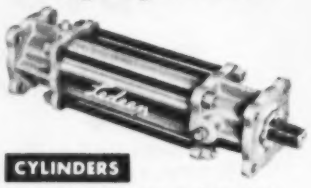

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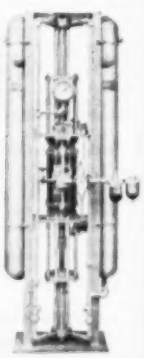

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LATEST INDUSTRIAL LITERATURE

270 RECORDING COUNTER

Streeter-Amet Co.—A recording counter adaptable for almost any application: counting electrical impulses, time intervals, revolutions, etc. Numerical totals are printed automatically on standard roll tape. The counter is capable of 1000 counters per min., $^1/_{100}$ of a minute in units of time, and up to 2000 rpm, and can be furnished to count during printing operation, or to cut-out counting circuit during printing. A wide variety of timing and printing mechanisms available as standard equipment

271 MATERIALS HANDLING AND PROCESSING EQUIPMENT

The Jeffrey Mfg. Co.—Catalog 825 describes the complete line of conveyors, packers, bucket elevators, vibrating feeders, weigh feeders, pulverizers, transmission machinery, grinders, shredders, magnetic separators, crushers, belt idlers, chain, electric controls, bin valves, dryers and coolers.

272 BEARING BRONZE

Bearium Metals Corp.—Three-color, 6-page folder describes the frictional properties available in Bearium Metal and illustrates typical bar stock sizes and individual castings. Photomicrographs show structure and lead distribution achieved in production of this metal, accounting for its advantages for bearings, bushings, thrust washers, and other requirements involving rubbing friction.

273 DUST FILTERS

W. W. Sly Mfg. Co.—Catalog describes dust filter equipment of the cloth-bag type for efficient collection of fine dusts from industrial operations. One type of filter has a motor-driven shaker for removal of collected dust; another filter, the Sly Dynaclone, employs the "reverse air" principle for dust removal.

274 LETTERING MACHINE

Ralph C. Coxhead Corp.—Bulletin tells how Vari-Typer lettering machine offers fast method of lettering bills of material, notes, specifications on tracings and drawings, and countless other drafting-room lettering details. A few of the many styles of instantly changeable type are illustrated.

275 TUBE FABRICATION

A. B. Murray Co., Inc.—Four-page folder describes bending swaging, upsetting, flame-spinning, pressure- and flash-welding of tubing and pipe in all metals, illustrated with pictures of equipment in operation and typical fabricated parts and assemblies.

276 BOILER FEED PUMPS

Pennsylvania Pump & Compressor Co.—New boiler feed pumps in 5, 6, and 7 stages with capacities to 1700 gpm and for heads up to 1200 psi are described in Bulletin No. 242. These continue the company's Thrustfre line of boiler feed pumps but feature a double suction impeller at first stage and are considered more suitable for hot water with lower net positive suction head.

277 BALL BEARINGS

Nice Ball Bearing Co.—New Catalog No. 150 lists standard radial, thrust, and combined radial thrust bearings of both precision and unground types, and includes several new lines recently announced. Ball bearing rollers, sheaves, wheels, and other anti-friction products are included, with capacity ratings, complete specifications, and engineering data.

278 LPD STRAINERS

J. A. Zurn Mfg. Co.—Several types of LPD (Low Pressure-Drop) Strainers for all purposes and ranging in sizes from $^1/_8$ to 24 in. are described and illustrated in this 16-page Data Manual No. 952. It carries information concerning the factors to be considered in selecting strainers for a specific application, and the effect of flow rate, screen loading, and the viscosity of fluid on pressure drop.

279 FASTENERS

Standard Pressed Steel Co.—A revised 32-page Catalog, "Unbrako Standards," describes in picture and text socket-head cap screws, set screws, square-head screws, shoulder screws, flat-head socket screws, button-head socket screws, pressure plugs, and dowel pins. The catalog stresses the use of standards as opposed to specials.

280 CAST STEEL GATE VALVES

Edward Valves, Inc.—A new 6-page Catalog section contains complete information on details of design, material specifications, pressure and temperature ratings, and dimensional details and weights of a new line of cast steel gate valves. Features of gate valves described include close-fitting guide ribs, one-piece bonnets, and ball bearing yokes. A special testing procedure designed to assure two tight-fitting faces is also described. Items cataloged include cast steel gate valves in 300-, 600-, 900-, and 1500-lb sp classes. All are furnished in sizes from $2^1/_2$ in. through 12 in. Flanged or welded ends are provided.

281 BIN LEVEL INDICATOR

Bin-Dicator Co.—New 1952 catalog fully describes and illustrates bin level indicator which gives automatic control of machinery in response to fluctuating level of materials in silos, bins, hoppers, conveyers, etc. Dimensional drawings, mounting details, typical applications, wiring diagrams, and list of present users. Illustrated applications to stoker operation, flour packing, chemical proportioning, concrete mixing plant, packaging ores, salt, feed, chemicals, candy, etc.

282 METAL-CLEANING COMPOUNDS

E. F. Houghton & Co.—Catalog describes the prescribed method of cleaning set forth in Government Manual TM-38-230, shows typical tank set-up and lists types of cleaner supplied for various plant purposes. It includes also a method of testing concentration of solutions.

283 ELEVATED STEEL TANKS

W. E. Caldwell Co.—New, Revised Bulletin ES-55 with illustrations and technical data on elevated steel tanks of standard and special designs contains complete information on tanks for town water supply, fire protection, industrial and institutional installations, and private water systems.

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LATEST INDUSTRIAL LITERATURE GUIDE

284 FILTERS

Cuno Engineering Corp.—A 6-page Bulletin No. PJL-1052 (formerly 1148-PJL) gives complete data on Cuno Auto-Klean filters—edge filtration plus positive mechanical cleaning; Cuno Flo-Klean filters—backwash filter cleaning with no loss of fluid; Cuno Micro-Klean filters—replaceable element micronic filters. Description of models for industrial filtration installations are included.

285 LOCK NUTS AND WASHERS

Illinois Tool Works, Shakeproof Div.—Catalog AS-46 features lock washers, pre-assembled screws and lock washers (Sems), thread-cutting screws, pre-assembled nuts and lock washers (Keps), and lock nuts (Lokuts). The locking action of Shakeproof products is explained and illustrated.

286 GAS COMPRESSOR VALVES

J. H. Voss, Inc.—Bulletin 53-G covers Voss Valves for the replacement of worn or inefficient valves in air, gas, and ammonia compressors. The valves are machined from solid stock and plates are machined and ground; valves and plates are of heat-treated alloy and stainless steel, and are designed to specification to fit the individual compressor for which they are manufactured.

287 BLADELESS SEWAGE AND TRASH PUMP

Fairbanks, Morse & Co.—Bulletin 5400K-1 describes the new Fairbanks-Morse bladeless sewage and trash pump, utilizing a single-passage bladeless impeller. Cutaway views and descriptive text explain the details of construction of the pump, both horizontal- and vertical-shaft models. Dimensions, specifications, and characteristics are given.

288 WELDED STEEL TUBING

Higbie Mfg. Co., Avon Tube Div.—An illustrated 12-page booklet shows the manufacture, properties, and applications of "Fusionweld" steel tubing. Sizes from $^{3}/_{16}$ in. OD to $^{9}/_{16}$ in. OD are listed with ultimate bursting strength and hydrostatic pressure. Special sizes are available. Tolerances and design information are included in the booklet.

289 LIMIT SWITCHES

National Acme Co.—National-Acme "Snap-Lock" limit switches are described in Bulletin EM-51, illustrated, 16 pages, which is designed with heavy covers and a reference tab for use in $8^{1}/_{2} \times 11$-in. files. The limit switches are made in four basic series: standard, short-travel, neutral position, and push lever. Specifications and ordering numbers and instructions are included.

290 GRATING, FLOORING, STAIR TREADS

Blaw-Knox Co.—Bulletin 2365 features the Electroforging—® process of manufacturing Blaw-Knox grating and stair treads. Illustrations, charts, and descriptive data point up the strength and permanence of Electroforged, one-piece construction of grating that has proved the ideal flooring for practically every industry. Two pages of this 16-page bulletin include an accurate table of safe loads, sizes, and specifications for Blaw-Knox grating and stair treads.

291 POLYVINYL PLASTICS

B. F. Goodrich Co., B. F. Goodrich Chemical Co. Div.—"Properties and Uses of Geon Polyvinyl Materials" lists the range of physical properties of flexible and rigid Geon plastics and gives applications for the more widely used formulations. Uses in extrusions, film and sheeting, and coatings are discussed at length.

292 SOLENOID-OPERATED ROTATING-DISK VALVE

Ledeen Mfg. Co.—Bulletin 1002 (supplement to Bulletin 1000) covers Ledeen Model PVN valves. These valves are solenoid-operated rotating-disk type, and have three positions: forward, reverse, and neutral. The valves are rated for maximum 150 psi service. Dimensions and weights of models are shown.

293 INDUSTRIAL COOLING FANS

Koppers Co., Inc., Aeromatic Propeller Dept.—A 4-page Leaflet on Aeromaster industrial cooling fans describes stages in the manufacture of the fans and the economy advantages of Aeromaster. Photographs of fans and a typical application are shown. Dimensional details and design information for one type of fan are shown. Ranges of size and capacity are given.

294 BRONZE AND COPPER CASTINGS AND BEARINGS

American Brake Shoe Co., National Bearing Div.—"Bronze and Copper Bearings and Castings" tells how National Bearing carries on its research, engineering, foundry, and finishing operations. Typical bearings and castings are shown, together with applications and corrosion recommendations. Properties of bearing alloys, specifications for as-cast and machined bars, and properties of babbitt metals are included.

295 QUICK-SCREEN-CHANGE HAMMER MILL

Schutte Pulverizer Co.—A new Schutte hammer mill featuring quick change of screen is described in a 4-page bulletin. Sizes from 20 to 125 hp are available in belt-driven and direct-connected models. Screens can be changed without stopping the mill or opening the cover.

296 SICROMATIC CHARTS

Marlo Coil Co.—For the first time in the history of air conditioning, coil selections can be made simply, accurately, and in a matter of seconds—from a single chart. This "Sicromatic" Chart and a special "Sicromatic" Rule used with the Chart are being offered to architects, designers, engineers and contractors.

297 SOLVENT-RESISTANT RUBBER

B. F. Goodrich Co., B. F. Goodrich Chemical Co. Div.—"Everywhere in Industry It's Hycar American Rubber" describes the properties and advantages of "Hycar" oil- and solvent-resistant synthetic rubber. A chart of the different types of this rubber gives their special properties and suggested uses. Vinyl and phenolic resin blends are included.

298 DIAL SCALES

Fairbanks, Morse & Co.—Bulletin 8102 contains information on Fairbanks-Morse bench and portable dial scales. Clearance dimensions and capacities of the different models are included, with an explanation of the working mechanism of the scales. Accessory equipment is also listed.

299 NON-SEGREGATED-CARBIDE TOOL STEEL

Latrobe Steel Co.—A 12-page Booklet, "Your Tooling and 'Desegatized' Steels", discusses carbide segregation in tool steel and its effects. The qualities and advantages of Latrobe's "Desegatized" steels, with uniform dispersal of carbides, are explained. The booklet is illustrated with cartoons.

300 CUTTING FLUIDS

D. A. Stuart Oil Co.—A reliable guide to better machining through proper selection and application of cutting fluids is offered. Contains handy chart which aids in selecting cutting fluids for various metal-working operations. Two articles—"Mechanisms of Metal Cutting" and "Chemistry of Cutting Fluids" will help the shop man to better understand cutting-fluid functions and enable him to obtain more efficient operation.

301 SPEED REDUCERS

D. O. James Gear Mfg. Co.—Herringbone-gear speed-reducers are cataloged in 60-page illustrated Catalog No. 40-C. Parallel-shaft, offset-drive, single, double, and triple reduction speed-reducers, with ratios from 2.1 to 370.1 and ratings from 0.5 hp to 5000 hp and straight-line drive, double reduction speed-reducers, with ratios from 11.1 to 76.5:1 and ratings from 0.8 hp to 800 hp are listed. Specifications and recommended practice for selection are included.

302 STEAM TRAPS

Clark Mfg. Co.—Information is available on a new development in steam trap construction, called Duo-Step Leverage. By using an ingenious double-fulcrum point and venting mechanism it is now possible to increase the drainage capacity of a trap so that it may handle twice the condensate formerly possible.

303 COIL SPRINGS, WIRE FORMS, AND METAL STAMPINGS

Dudek & Bock—Bulletin shows how the manufacturer's free design service can save users many dollars. Learn of the special instruments developed to take the guesswork out of specifying, inspecting, and testing. Includes valuable engineering charts and data in easy-to-understand language.

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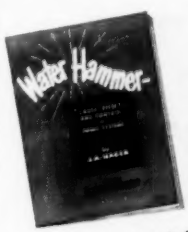

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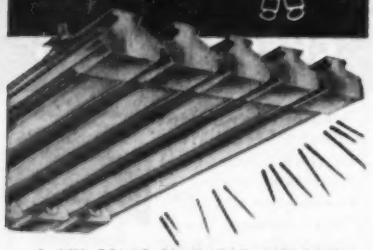

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304 VENTILATING UNITS

Trane Co.—"Unit Ventilators" (Bulletin DS-430) shows the different models of Trane unit ventilators, their construction, and mechanical and architectural specifications. Cycles of operation are illustrated, and roughing-in dimensions and application suggestions are included. Four pages of capacities are appended.

305 INDUCTION HEATING

Ohio Crankshaft Co., Tocco Div.—New catalog 22, 20 pages, describes the principles, applications, and equipment of Tocco induction heating. Typical results of induction hardening and heat-treating, and results of induction heating for forming and forging are given.

306 BOILERS

Farrar & Trefts, Inc.—Catalog describes heating and power boilers of welded construction with a range in capacities from 10 hp to 359 hp, and in working pressures from 15 lb to 500 lb; heating boilers for low-pressure, steam and hot-water service; and, power boilers built to meet all code requirements and carrying S.B.I. label.

307 PRESS BRAKE DIES

Service Machine Co.—Press brake dies made from forged-steel billets in a manner claimed to outlast ordinary dies at least ten times are described in a new Semco color folder, entitled "32 Year Brake Dies." The folder illustrates steps in the manufacture of the dies.

308 NAME-PLATE STAMPING

Acromark Co.—"How to Stamp Name Plates" is the title of a color folder illustrating a wide variety of sizes of name plates, together with five different groups of available equipment for "filling in" or otherwise marking these name plates with lettering, design, trade-marks, numbers (including consecutive serial numbering), etc. The tools and machines range from single steel letter and figure stamps to completely automatic motor-driven equipment.

309 FINISHING TOOL

Nord International Corp.—The Di-Profiler provides reciprocating, rotary, and oscillating action in one complete tool assembly 50 times faster than hand filing, it is claimed. The new tool hones flat or contoured surfaces, laps, files, scrapes, sharpens, grinds internally, and does die finishing and other finishing jobs. A new 50-page bound book covers the technique of die finishing.

310 DEWATERING STORAGE BINS

United Conveyor Corp.—Bulletin illustrates special design for elevated ash storage bins which are required to receive a mixture of water and ash from a hydraulic conveying system and drain water from bin so that commercially dry ash can be loaded by gravity into railroad cars or trucks. Equipment is particularly suitable for the large boiler plants where there is no fill ground available that can be used as an ash fill.

311 DRAWING AND TRACING PAPERS

Frederick Post Co.—A sample book of their complete line of tracing papers and cloth, vellums, drawing papers, and cross-section and graph papers is offered for use in selection of tracing and drawing media.

312 AIR CONDITIONERS, HOT-WATER HEATERS, HEATERS

Surface Combustion Corp., Janitrol Div.—"Automatic Janitrol Heating Equipment" contains performance data and dimensions on these home units: gas- and oil-fired air conditions, gas-fired gravity and floor furances, gas- or oil-fired hot-water boilers, gas-fired hot-water or steam boilers, gas-fired unit heaters, gas-fired heavy-duty heaters, gas conversion burners, an other equipment.

313 ROLLER CHAIN

Atlas Chain & Mfg. Co.—Authoritative 32-page handbook and catalog tells how to install, maintain, and operate roller chain. The handbook describes chain-drive layouts and offers valuable hints on roller-chain selection and lubrication. Length-conversion tables, horsepower-rating charts, and list prices with specifications for all types of roller chain and extended pitch conveyor chain are contained in the book.

314 COUNTING SCALE

Toledo Scale Co.—A booklet, "Counting Scales" (Form 2204), describes the principles and procedures for high-speed counting parts and pieces by weight, and illustrating and describing the types of scales most widely used for this purpose.

315 INDUSTRIAL INSULATIONS

Johns-Manville—A 40-page catalog, Brochure GI-6A, with descriptions, uses, and sizes of the principal products in the J-M industrial line. It illustrates and describes various types of J-M industrial insulations, and also serves as a reference catalog for information on J-M asbestos-cement pipes, friction materials, electrical materials, packings, flooring, and roofing.

316 INDIRECT FIRED HEATER

Brown Fintube Co.—Fired indirect heater for heating air, special atmospheres, corrosive and non corrosive gases, thermal chemicals and circulating oils, asphalts, and other services requiring temperatures up to 1500 F. The 2 in. to 8 in. finned combustion tube is of carbon-steel, stainless-steel, inconel, or monel construction, and gas or oil fired. It delivers up to 1,000,000 Btu per hr input to the material. Bulletin No. 522 gives full information, including operating details of 12 typical installations.

317 INVESTMENT CASTINGS

Engineered Precision Casting Co.—"Investment Castings," how they are cast in all metals, the process of manufacture and the precision to which they can be cast are covered in detail in a new 8-page brochure. A variety of examples of intricate cast parts produced in such metals as stainless steel is shown. The manufacturing process is described and illustrated.

318 FACTORY-ASSEMBLED BOILER

Erie City Iron Works—Bulletin SB43 describes the VL-2-drum water-tube self-contained furnace-boiler. These factory assembled boiler-furnace units are available through 300 hp for oil, gas, underfeed, or spreader-stoker firing. Larger sizes for field erection. 20-page catalog gives concise engineering data and includes large user list.

319 BASEBOARD HEATING CONVECTORS

Trane Co.—Bulletin DS-381, "Hidden Heating with Baseboard Convectors", describes Trane's line of baseboard heating units. The baseboard convectors come in two sizes, 8¼ in. high and 12 in. high. A cutaway view shows the features of the heaters, and is followed by a table of capacities. Suggested piping layouts and baseboard system controls are given, together with installation instructions. "Greater Comfort for Your Home—Hidden Heating with Trane Baseboard Convectors" is a colorfully illustrated 6-page folder describing the advantages of baseboard convectors in simple, non-technical language.

320 PANTOGRAPHIC ENGRAVING

H. P. Preis Engraving Machine Co.—Engraving ratios 1:1 to infinity are accomplished with Preis-Panto Model 2D-4 Engraving Machine, described in a new folder entitled "Engraving Machines and Accessories." The folder lists more than 15 different machines, tools and accessories used in the machine shop for engraving, routing, and light precision milling.

321 THERMOSTATIC SWITCH

Fenwal Inc.—A new 52-page three-color Catalog No. 400 on Thermoswitch temperature controls describes the design, operating characteristics, and installation of each of the 10 variations on the basic Fenwal thermostatic device. A special section concerning the selection and application of the Thermoswitch discusses such subjects as operating differential, sensitivity, temperature variation, lag and overshoot, characteristics of heat sources, frequency of switching and installation in solids, liquids, and gases.

322 GAS BURNERS

American Gas Furnace Co.—New burner catalog includes complete operational and physical data with illustrations and descriptions of a variety of such products as blow pipes, pressure regulators, pressure air mixers, open-flame burners, blast-ring burners, glass fires, cross fires, fish-tail burners, manifolds, hand torches, machlet tips, venturi mixers, burner tunnels, zero governors, single-valve

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ratio sets, oxygen-gas burners and tips, turbo-compressors, intake air filters, gas boosters, flow meters and other items.

323 SOOT BLOWERS

Hahn-Pitz Corp.—New Bulletin No. 71 describes mechanical soot-blowers for fire-tube boilers. Adaptable to H.R.T., Scotch marine and fire-box types, these blowers have no moving parts within the boiler, with no scoring of the tube sheet. For existing boilers or new installations.

324 SPEED REDUCERS AND GEARMOTORS

Abart Gear & Machine Co.—A pocket-size catalog of Abart speed reducers and right-angle gear motors, 96 pages, book gives complete engineering data on how to select the proper speed reducer to fit requirements, including horsepower ratings, ratios, and installation graphs.

325 O-RING SEALS

Goshen Rubber Co., Inc.—Catalog C, 28 pages, contains tabulated data, including standard dimensions, for AN6227 and AN6230 O-ring packings and gaskets, complete installation dimensional recommendations, and guide of material compounds for commercial applications. Engineering drawings illustrate various installations.

326 SLEEVE-TYPE BEARINGS AND BUSHINGS

Cleveland Graphite Bronze Co., Div. of Clevite Corp.—A condensed 12-page Catalog, "Presenting Bearings and Bushings," illustrates the range and variety of products manufactured in the world's largest bearing plant. Bushings, thrust bearings, heavy-wall bearings, main and connecting rod bearings, aircraft engine bearings and cam-shaft bearings are described and pictured. Also included is description of research and development work, and material analyses for 19 bearing alloys.

327 WATER CHILLER

Servel, Inc.—Information about the application and flexibility of the Servel 25-ton Water Chiller for air conditioning, process cooling, and industrial precooling which solves cooling problems with waste heat or low cost steam is described.

328 VALVES

Lunkenheimer Co.—The new 500-page Lunkenheimer Catalog features a three-color illustrated Guide section, where popular valves are grouped by pressure classes for easy comparison. More complete details can be found by referring to the four-way index. Dimensions, prices, and performance data of valves are contained in the catalog.

329 FASTENERS

Townsend Co.—A 12-page Brochure of information, TL-68, covers cold-forming all types of metal fasteners, gadgets, locknuts, Cherry blind rivets, and twinfast wood screws, plus a resumé of design services available.

330 CLUTCHES

Borg-Warner Corp., Rockford Clutch Div.—Bulletin 4A/13 is a catalog condensation of a wide variety of types and sizes of clutches, both automotive and industrial, which also describes power take-off and gear reduction units. Illustrations are included, with description and specifications.

331 ROTOR VANES

National Carbon Co.—Catalog Section S-5430, "'National' Carbon Rotor Vanes," describes the unique advantages of carbon as a rotor-vane material in sliding-vane-type rotary pumps and compressors.

332 GAGES AND THERMOMETERS

Marsh Instrument Co.—Catalog No. 76-G describes in detail a wide line of industrial gages and thermometers. The catalog is fully illustrated, including cut-away photographs and enlargements of internal parts. It covers also gage accessories, specifications, including line drawings, dimensional tables, and templates covering every size and pattern.

333 FLEXIBLE COUPLINGS

Poole Foundry & Machine Co.—Catalog No. 52 describes all the types and sizes of flexible couplings which they manufacture. Complete engineering data, horsepower ranges, shaft sizes, etc., are included. Several new-type disengaging couplings and the new NEMA standards are incorporated in this new issue.

334 NEOPRENE AND SPONGE RUBBER SHEETS

Johns-Manville, Van Cleef Bros., Inc., Div.—New technical data sheets concern Dutch Brand Natural Sponge Rubber in soft, medium, firm and hard densities to meet ASTM specifications No. D1056-51T; RN11, RN12, RN13, and RN14; Neoprene in soft and medium densities to meet ASTM specifications SC11 and SC14. Standard colors are brown, gray, red and green, and special colors. Thicknesses 1/8 in. to 1 in. inclusive, rolls, sheets, strips with or without adhesive; die cut forms and custom molded pieces.

335 STEAM TRAPS

Strong, Carlisle & Hammond Co.—Strong Steam Specialties Catalog 68 ME illustrates and describes Strong Steam Traps, inverted-bucket, open-float, and thermostatic type, line strainers, pressure-regulating valves, pressure-reducing valves, separators, and steel "Evrtyte" valves. Engineering

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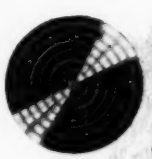

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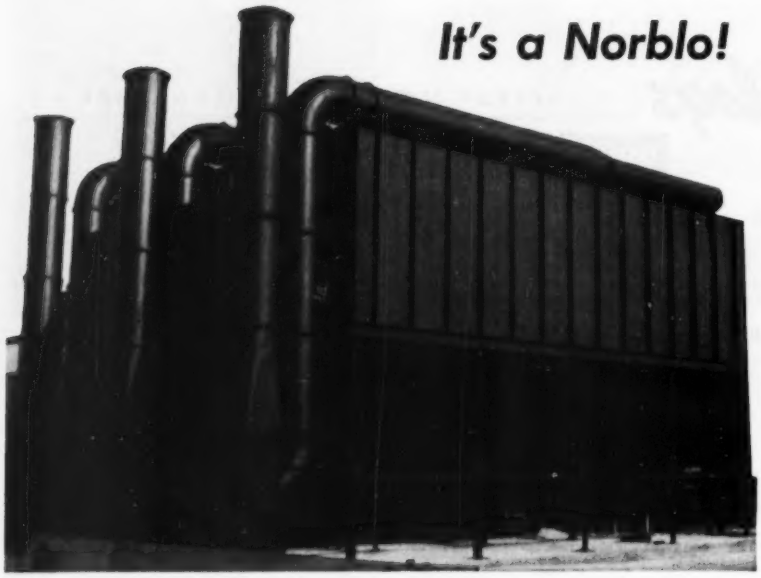

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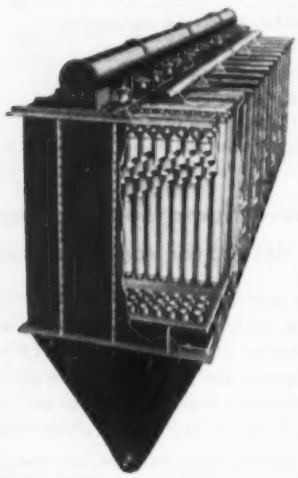

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336 SURFACE ROUGHNESS

Micrometrical Mfg. Co.—New 24-page Catalog of Profilometer equipment for shop measurement of surface roughness describes Amplimeter, Tracers, manual and motor-driven piloting equipment, and items in development, and includes specifications, prices, and photos of equipment in use. Lists of typical combinations of Profilometer equipment commonly selected for various job requirements are presented.

337 SPROCKETS, BUSHINGS, AND ROLLER CHAIN

Dodge Mfg. Corp.—A new illustrated Bulletin A-624 contains complete data on the new line of Dodge Taper-Lock Sprockets, Taper-Lock Bushings, and Roller Chain for sizes 40, 50, 60, 80, and 100. Technical information and selection data covers a range of pitch sizes of 1/2 in., 5/8 in., 3/4 in., 1 in., and 1 1/4 in., and includes a complete list of Taper-Lock Bushings for bores ranging in sizes from 1/2 to 3 in., inclusive, and the number of teeth in which each size sprocket is availalbe; the complete range is from 9 to 112 teeth. List prices of sprockets, bushings, chains, and links are also included.

338 DRAWING INSTRUMENTS

Theo. Alteneder & Sons—Catalog includes drawing instruments and scales, stainless steel straightedges, stainless steel T-squares and stainless steel triangles and protractors for engineers and surveyors. Special instruments requiring precision can be made to order. Rules are made from wood, plastic, stainless steel, brass, nickel silver, and aluminum, and are engine-divided to special calibrations.

339 GRAPHALLOY PRODUCTS

Graphite Metallizing Corp.—Catalog 112 describes metal-impregnated self-lubricating bushings which contain no oil and require no oil. Grades suitable for a wide range of loads, speeds, and temperatures are suggested. Graphalloy bushings, patented in 1913, are used successfully in high, room, or extremely low temperatures; in applications where high loads or high speeds do not permit conventional lubrication; and in submerged installations.

340 FURNACE CONSTRUCTION

M. H. Detrick Co.—A 50-page illustrated booklet, "Heat Enclosure Methods," outlines the development of furnaces and furnace construction. Suspended arch and wall constructions and their applications are shown for boilers, oil heaters, heating and melting furnaces, and other units. Engineering graphs and tables are presented to help select proper construction for any given conditions.

341 VARIABLE-SPEED DRIVES, CONTROLS

Reeves Pulley Co.—Bulletin G-509-1 describes the complete Reeves line of variable-speed transmissions, Vari-Speed Motodrives, and Vari-Speed motor pulleys. Special types of controls adaptable to these drives also are described. Overall dimensions of standard Reeves equipment, horsepower capacities from fractional to 87 hp for Reeves drives, and a section devoted to general engineering information are included.

342 SCALE AND CORROSION CONTROL

D. W. Haering & Co., Inc.—"Solution to Your Problem of Scale and Corrosion Control" catalogs the application of Haering H—O—H Glucosates to problems of scale and corrosion in water-using equipment. The booklet tells the particular use each glucosate has in correction and control of scale-formation and corrosion.

343 TANK HEATING AND COOLING

Kold-Hold Mfg. Co.—Tank heating and cooling is described and illustrated in a new 6-page bulletin. A direct comparison is made between the "Platecoil" and pipe-coil methods of heat exchange. The bulletin shows the advantages of "Platecoil" in time, money, and manpower for the user.

344 NON-ELECTRIC MAGNETIC SEPARATORS

Eriez Mfg. Co.—Catalog 15-a lists the Eriez line of non-electric permanent magnetic separators, gives their advantages, and contains tables of sizes and weights. Magnetic pipeline traps, assemblies for installation of magnets in pneumatic lines, liquid lines, and gravity flow chutes, magnetic-pulley separators, and rotary floor magnets are among the equipment listed.

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345 CONTROL VALVES

Hydropress, Inc.—Bulletin L-43, issued by Loewy-Hydropress, with illustrations descriptive of water-hydraulic high-pressure controls, deals with hydraulic control valves, pre-filling valves, stop valves, check valves, by-pass valves, shut-off valves for hydraulic accumulators, and combination valves for sequence operation.

346 ROLLER AND DETACHABLE CHAINS

Chain Belt Co.—Bulletin No. 52-2, distributed by the Baldwin-Duckworth Div., gives information on the Baldwin Assembly Riveted Roller Chain. List prices, strengths, dimensions, and weights of standard roller chains are included. Bulletin No. 51-10, distributed by Baldwin-Duckworth Div., covers "Tension Linkage" chains, described as chain applications in which linear movement of the chain is not continuous in direction; the chain may not be continuous. Bulletin No. 52-52 describes Rex Steel Detachable Chains, showing plain chain and attachments and their dimensions, weights, prices, etc. A section on chain theory, chain travel, recommendations for drives and conveyors, sprocket theory, and sprocket design is added.

347 DIRECT-FIRED HEATERS

Arthur A. Olson & Co.—Catalog No. D52 contains information of gas, oil, coal, or dual gas-and-oil direct-fired automatic heaters, with capacities from 300,000 to 7,500,000 Btu per hr. Steps in the heater operation are explained with cutaway views, and data on the different models are given.

348 LOCK NUTS AND LOCK WASHERS

Standard Locknut & Lockwasher, Inc.—Bulletin No. 30 describes Standard's line of lock nuts and lock washers for ball- and roller-bearing applications, designed to SAE and ABEC applications. Dimensions of lock nuts, lock washers, and shafts are included.

349 FIRE EXTINGUISHING

Grinnell Co., Inc.—More effective control of fire, with less water, for a wide variety of hazards is described in "Grinnell Automatic ProtectoSpray", which explains a new coordinated three-way attack upon fire. It has special value for fire hazards involving high-piled storage, rubber, flammable liquids, paints and flash-fire materials.

350 INDUSTRIAL PUMPS

Deming Co.—Ninety-six pages of illustrated information about numerous types of industrial pumps manufactured by the company are contained in Industrial Catalog I-52. The contents include sectional and exterior views of the various types of units, together with selection tables and other data of interest to pump users.

351 O-RINGS

Plastic & Rubber Products Co.—An 8-page Catalog on O-ring design and development includes tables on dimensions and groove data for various styles of O-rings. The design data has such information as installation and design, external and internal installation with nominal and non-standard dimensions, surface finish of glands and static seals, and dimensional drawings, charts, and tables.

352 ELECTRONIC AIR CLEANERS

Trion, Inc.—Catalog E-60 explains the electrostatic precipitation of dust, dirt, smoke, bacteria, and other contaminants, and the features of Trion electronic air cleaners. Capacities, dimensions, and weights of the different models available are listed, including specifications for packaged units. A 4-page folder on the Dill Dust-Spot Tester, manufactured to National Bureau of Standards design, explains the instrument, which determines air filter efficiency, and gives its specifications.

353 PRECISION INVESTMENT CASTINGS

Austenal Laboratories Inc., Microcast Div.—"New Opportunities of the Creative Product and Design Engineer" is a colorfully illustrated booklet on the Microcast precision investment-casting process, its characteristics and advantages. Properties of typical alloys used and examples of dimensional tolerances are included.

354 HEAT EXCHANGER

Bell & Gossett Co.—Catalog No. DM-1150 contains an extensive table of applications to various industries of heat exchangers, heaters, coolers, and condensers, together with specifications and detailed

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In this application the waveforms were recorded by an oscillograph-record camera.** Measurements made directly from the photographs show that the valve (Channel B) opens fully in approximately 1/10th second following the initiation of the control pulse (Channel A). A long-persistence screen such as a P7 screen could be used for visual measurements directly from the screen of the cathode-ray tube.

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applications of B & G's principal models. Refrigeration equipment, centrifugal pumps, gas coolers, and water heaters are included. Eight pages of engineering data are in the 28-page booklet.

355 BEARINGS

Gwilliam Co.—Sectional illustrations and tabular data of standard bearings carried in stock, and special bearings are described in Catalog No. 28. Ball, roller, and journal bearings are listed.

356 VALVES

Hays Mfg. Co.—Bulletin No. 117 discusses the Hays "Electroflo" valve for appliances and industrial equipment. The Electroflo valve is used for the control of water, oil, steam, and air. Cutaway drawings illustrate the several models. Three selections of piping methods are illustrated.

357 INSTRUMENTS—RECORDERS

Brush Electronics Co.—Brush oscillographs, amplifiers, acoustical instruments, recording analyzers provide immediately usable, permanent records on electrical, mechanical or acoustical investigations on items such as surface finish, textile fiber uniformity, d-c or a-c voltages or currents, strains, displacements, light intensities, temperatures, other static or dynamic conditions.

358 DROP FORGINGS

Drop Forging Association—"Metal Quality—Hot Working Improves the Properties of Metal," a 64-page booklet recently revised and issued by the Technical Committee, Drop Forging Association, for design engineers, metallurgists, and production-management executives, explains how hot-working improves metal quality. The text describes forging-quality steel and details of the various methods of forging. Check lists of the advantages obtained by use of forgings, economic benefits, are included.

359 SPACE HEATERS

Dravo Corp.—Bulletin No. 526 describes Dravo "Counterflo" direct-fired space heaters in a range of gas- or oil-fired models with outputs from 400,000 to 2,000,000 Btu per hr. A comparison chart shows that steel requirements for these heating systems can be reduced 50 to 70 per cent through the use of direct-fired warm air heaters.

360 BITUMASTIC PROTECTIVE COATINGS

Koppers Co., Inc.—Informative package of six bulletins covers (1) Bitumastic Hi Heat gray for high-temperature corrosion prevention; (2) Bitumastic Black Solution for general, low-cost maintenance; (3) Bitumastic Super-Service Black, heavy-duty coating for more severe conditions; (4) Bitumastic No. 50, extra heavy-duty coating for extremely severe corrosive conditions; (5) Bitumastic No. 28, heavy-duty coating for atmospheric corrosion control; (6) Bitumastic Tank Solution, quick drying, useful for water tanks, etc.

361 ELECTRIC RADIANT PANELS

Edwin L. Wiegand Co.—New Chromalox electric radiant panels are described in illustrated 6-page bulletin, CS-605. Folder explains how this new infrared generator can be used for paint baking, curing, drying, degreasing, and other operations. Dimensions, ratings, and intensity controls are also listed.

362 VALVES

Homestead Valve Mfg. Co.—Reference book 39-3 offers complete information on Lever Seald Valves made of brass, semisteel, cast steel, and other metals for specific service conditions. Specifications for these valves, which feature "stickproof" operation, are given in charts, with photos and line drawings illustrating each type valve. Also included in this 16-page catalog are on-the-job photos of Lever Seald Valves, illustrating their many uses.

363 GENERAL PURPOSE TURBINES

Westinghouse Electric Corp.—Booklet No. B-3896. The type-E turbine will perform a number of jobs well even under abnormal operating conditions. Designed for economy and dependability in continuous or stand-by operation. An excellent means of effecting steam expansion without loss of energy. Fully illustrated and diagrammed.

364 CONVEYERS

Mathews Conveyer Co.—Catalog 151, 68 pages of design details and illustrations cover roller and wheel conveyers. A complete line of high-quality rollers ranging in diameter from 1 in. to 6½ in., and in capacities from 50 to 16,000 lb is shown in convenient sequence. Wheel conveyers are described and illustrated.

365 LUBRICATING SYSTEM

Trabon Engineering Corp.—Bulletin No. E463 describes operating principles and engineering data on type "M and MX" oil and grease systems for all types of machinery. Fully hydraulic positive-piston-type valves measure lubricant in volumes from 0.010 to 0.15 cu in., use no springs or ball check valves. May be installed on new or machinery already in operation.

366 THRUSTORQ FORCE-MEASURING DEVICE

Hagan Corp.—The Hagan "ThrusTorq," air-operated force-measuring device is pictured and described in bulletin No. 9345. The ThrusTorq is employed in engine-testing laboratories, engine and aircraft factories, automotive and petroleum industry laboratories and plants, and in chemical and other plants for continuous and intermittent weighing applications.

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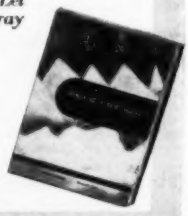
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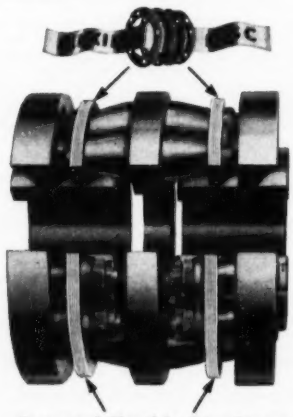

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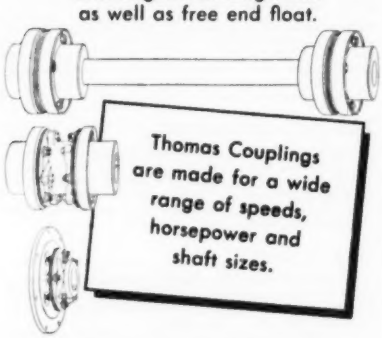

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367 EFFECTS OF CHECK VALVES IN OVERCOMING WATER HAMMER

Williams Gauge Co.—The cause, effect, and control of water hammer in piping systems are considered in a new 8-page bulletin. After describing water hammer in nontechnical terms, the brochure indicates its potential damage to piping, instruments, and other parts of water systems, and then considers methods of controlling it.

368 WATER VAPOR PHYSICS

Pittsburgh Lectrodryer Corp.—Bulletin No. 218, "The Moisture in Our Atmosphere," a 12-page bulletin, discusses the fundamental physics of water vapor. The nature and behavior of water vapor are treated in a logical down-to-earth manner with psychrometric chart explanations. The use of solid adsorption equipment for dehumidification is also described.

369 ELECTRIC MEASURING INSTRUMENTS

Westinghouse Electric Corp.—Booklet B-4696 covers the most complete line of electrical measuring instruments in the industry—portable, panel, switchboard, socket, and recording—for measuring all electrical quantities. This fully illustrated booklet also tells how to select, apply, and order Westinghouse instruments.

370 STAINLESS-STEEL SHEET AND STRIP

Washington Steel Corp.—A new bulletin describes MicroRold stainless steel sheet and strip, produced by the Sendzimir process of continuous cold reduction. Physical properties, specifications, standard type numbers, and analysis of MicroRold stainless are included. Featured by type number is a discussion of the application and uses of each type of MicroRold.

371 LUBRICATED PLUG VALVES

Homestead Valve Mfg. Co.—Reference Book 39-5 contains complete information on the expanded Homestead-Reiser lubricated plug valve line. Catalog includes valve cross-sectional views, photographs, dimensions, and information for ordering. In addition, complete specifications are given for the new venturi-type, worm-and-gear controlled, steam-jacketed bonnet, and three-wave valves, all recently added to the line.

372 HYDRAULIC TURBINES

James Leffel & Co.—Two new bulletins tell about recent Leffel hydraulic installations. Bulletin No. 1085 describes the Leffel installation at the Bureau of Reclamation's new Anderson Ranch Dam, with photos, statistics, etc. Bulletin No. 1086 contains information on a Leffel turbine used in the expansion of TVA's Wilbur Dam, with photos, field-test results, cross-section of installation, etc.

373 PLASTIC GEARS

Westinghouse Electric Corp.—MICARTA phenolic laminate gear material for silent gear operation. 30-times greater tooth deflection than steel. Sixteen-page book No. B4661 complete with design tables and formulas along with application and machining information.

374 DRAFTING-MACHINE SCALES

Universal Drafting Machine Corp.—Bulletin gives complete information on the advantages of this extremely accurate, ground from the solid, aluminum scale, and in addition provides a valuable chart of 3/4 size actual scale photographs showing all the standard Duraline Scale graduations commonly used by engineers, draftsmen, architects, and designers. It also provides an explanation of scale terminology in general use—to aid buyers when writing for information on specially graduated scales for special uses.

375 CORROSION-RESISTANT VALVES

Rockwell Mfg. Co.—Catalog V-217, "Rockwell-Built, Nordstrom Corrosion Resistant Valves," designed specifically for use in the process industries, describes types, operation, and features of Nordstrom corrosion resistant valves. Tables are included listing approximately 175 different chemicals, with special reference to their recommended alloys and lubricants. Typical chemical analyses are made of bronze, Mercoloy, Ni-Resist, stainless steel, nickel, monel, and Hastelloy. In addition to size and specification tables, over 100 illustrations show valve sizes, types, and practical applications in the process industries.

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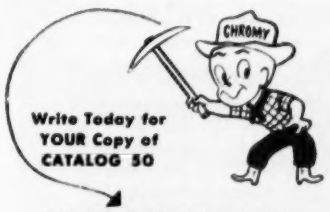

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376 HYDRAULIC LUBRICANT PUMP

Trabon Engineering Corp.—Bulletin No. 514 gives complete data on the "Hydra-Lube" pump and reservoir assemblies for oil or grease systems. Readily adaptable to machine tools, mining machines, presses, and other equipment using hydraulic power. Adjustable volume discharge gives fully automatic lubricating system without electric or mechanical connections.

377 PNEUMATIC INDUSTRIAL CYLINDERS

Westinghouse Air Brake Co.—A new streamlined class of pneumatic industrial cylinders—both with noncushioned and cushioned adjustable stroke—are described in leaflet No. 9458-I. Solid barrel construction with rotating heads provides compactness and ease of installation. They are available in diameters from 1½ in. up with stroke and mounting to suit any requirement.

378 BOILERS AND STOKERS

James Leffel & Co.—28-page Bulletin No. 236, describes 6-hp to 250-hp (these are normal and conservative ratings and are subject to considerable overload capacities) Leffel Scotch-type boilers and underfeed stokers. Photos and cutaway drawings show design and application details. Test results, case studies, and specification data are included. The Leffel automatic underfed stoker is also suitable for other makes of Scotch-type boilers.

379 CONDENSIFILTER

Hankison Corp.—Hankison model B-30 Condensifilter, which removes water and oil from compressed air used to operate instruments, is described in a new two-page bulletin. Measuring only 15 in. high × 9 in. in diam, this compact unit removes water by condensing the air through passing it over a series of cooling copper coils, then removes oil, sludge, and other foreign material by passing the compressed air through a filter cartridge consisting of five hexagonal chambers in parallel. Self-purging trap automatically discharges the condensate.

380 VALVES

Wm. Powell Co.—New 589-page No. 11 General Catalog describes in detail the standard Powell bronze and iron valves, quick-opening valves, and all-iron valves.

381 PIPE AND TUBES

National Tube Co., Tubing Specialties Div.—Bulletin 26 presents technical data on 25 alloy steels suitable for high-pressure high-temperature service. Includes many tubular products manufactured in accordance with ASME Boiler Code specifications. Relative cost figures aid in selecting best alloy for special service.

382 ELECTRIC MOTORS

Westinghouse Electric Corp.—Booklet B-4731 describes the new Life-Line motors which are available up to 700 hp for all industry. Especially designed to eliminate excessive working costs and to give top electrical performance, these Life-Line motors are constructed in steel for greater protection against shock and strain. Dust, dirt, and dampness, the enemies of electrical apparatus, are crippled by the exclusive mechanical and electrical devices included. Drip-proof, splashproof, vertical motors are features in this booklet.

383 ROLLING DOORS

Kinnear Mfg. Co.—New 32-page fully illustrated bulletin No. 76 on a galvanized steel sectional overhead-type door that combines durability with operating convenience and facilities for glass light sections in a door for all types of commercial and industrial service openings is offered. It gives details, clearance requirements, and available accessories.

384 HEAT EXCHANGERS

Sims Co.—Six-page folder gives dimensions of both stuffing-box-type heat exchanger with floating tube element and the fixed-tube plate-type heat exchanger. Numerous special heat exchangers are pictured.

385 INDUSTRIAL METER SELECTION

Rockwell Mfg. Co.—A new bulletin, No. OG-400, intended to guide the proper selection of meters for measuring more than 200 chemicals, petroleum products, and other liquids with varying corrosive characteristics is available. In addition to the complete table of metered liquids matched with case, chamber, and piston specifications, the bulletin also includes a simplified specification sheet which makes it easy for the customer to cover all necessary operating requirements so that proper meter recommendations can be made at the factory.

386 PROTECTIVE COATINGS

Pittsburgh Coke & Chemical Co.—A new booklet on Pitt Chem Cold Applied Tar Base Coatings describes the properties of the four types of coatings manufactured by the company and gives application directions. A full-page chart lists a comprehensive selection of typical structures and corrosive agents and recommends the coatings best-suited for each application.

387 VALVES

Ohio Injector Co.—A new catalog 51-FS shows a complete line of 600-lb forged steel, gates, globes, angles, checks, and screwed flanged socket-weld type in standard and special trim.

388 PHOTOELECTRIC COUNTER

Photoswitch, Inc.—Bulletin PA506 describes a completely packaged general purpose photoelectric counter, Photoelectric Counter Set PEC. The set consists of a photoelectric control, light source, and electric counter; remote counting is possible with the device, standard 115-v a-c power is utilized, and counting speed of up to 600 counts per min is claimed.

389 FANS, ECONOMIZERS, AND DUST COLLECTORS

Green Fuel Economizer Co.—Bulletin No. 168 is a 20-page catalog describing in detail the several types of Green forced- and induced-draft fans. Various types of blades, dampers, and vanes are discussed. An 8-page catalog, Bulletin No. 169, describes the line of Green "Premier Diamond" Economizers, with detailed information on cast-iron and steel tube construction. Bulletin No. 170, 4 pages, covers the Green "Aerodyne" Dust Collector in its applications for controlling fly-ash discharges from power-plant stacks.

390 METERING AND PROPORTIONING PUMPS

Hills-McCanna Co.—Catalog UP-52R contains information on U-type metering and proportioning pumps, of 0.10 to 24 gal per hr per feed. Features and advantages are explained and capacities, service recommendations, and dimensions are tabulated.

391 CEMENTED CARBIDE TOOLS

Kennametal Inc.—The variety and range of sizes of cemented carbide tools available is presented in 64-page illustrated Catalog 52. It lists brazed tools, blanks, top-clamp Kennamatic tools, Kendex tools, Kennamills, and many others. Specifications, properties, and general data are also given.

392 HEAT EXCHANGERS

Pressed Steel Tank Co., Downingtown Iron Works, Inc. Div.—Catalog contains details of heat exchanger section, performance, mechanical design, tube-sheet layout with tables, illustrations, etc. A partial analysis of ASME code for unfired pressure vessels is included.

393 VALVES

DeZurik Shower Co.—Catalog describes the line of plug valves and contains an extensive list of recommendations of materials for specific fluids, solutions, suspensions, etc. Advantages of DeZurik valves including the cylinder-operated valve-positioner are explained. Specifications for pipe-line strainers, gate valves, cast-steel globe and angle valves are included.

394 ASPHALT HEATER

Todd Shipyards Corp., Combustion Equipment Div.—Bulletin describes the Todd Thermo Convective Asphalt Heater and gives details of combustion chamber, tubular heat-exchanger, and related auxiliaries. The unit is especially designed to heat asphalt economically.

395 STEAM, AIR, AND GASOLINE TRAPS

W. H. Nicholson & Co.—The 32-page, illustrated Catalog No. 751 describes: five types of thermostatic steam traps for pressures to 225 lb; two types of expansion steam traps for pressures to 250 lb; three types of weight-operated traps for steam, air, and gasoline, pressures to 1500 lb; piston-operated steam traps for pressures to 650 lb; and three types

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of steam, air, and gas separators. The catalog is complete with capacity tables, installation diagrams, and a section containing data, charts, and formulas for determining the proper size trap for specific applications.

396 PRESSURE INDICATOR, FLOWMETER

Control Engineering Corp.—Bulletin EP4 contains information on the firm's Engine Pressure Indicator with a Catenary Diaphragm, which is designed for measuring pressure-time curves in internal combustion engines at both high detonation frequencies and low power stroke frequencies. Accessory equipment is also described. Bulletin LP-1 covers Low-Pressure Indicators, which are suitable for use in measuring pressure in engines under conditions of extreme vibration. An Advance Descriptive Sheet discusses the principles, operation, and advantages of the True Mass Rate Flowmeter, available at present only as a custom-built device. The flowmeter is claimed independent of factors of density, viscosity, volumetric flow rate, temperature, pressure, or compressibility of fluid.

397 COUNTERS

Veeder-Root Inc.—Catalog No. G51 illustrates and gives specifications and dimensions for Veeder-Root counting devices, both standard stock counters and non-standard counters, which have optional features. A 7-page Application Index lists the types of counters usable in general types of machines and equipment. Special counting devices for specific or limited applications are also shown.

398 VALVES AND FILTERS

Automatic Switch Co.—Asco Solenoid Valves are described in Catalog No. 24, which includes a valve-selection chart of recommended valves for classes of fluids, flow charts, and general information and terms for the valve user. Safety shut-off and manual reset valves, packless and packed valves, three-way valves, pilot-controlled valves, four-way valves, and strainers and filters are covered. Special Bulletin 8336, "Solenoid Pilot-Controlled Valve," Bulletin 8035, "Pressure-Operated Manual-Reset Valve," and a Valve-Delivery Schedule for orders, all printed separately, are available.

399 FLEXIBLE SHAFTS

Stow Mfg. Co.—Engineering Bulletin No. 525 and Slide Torque Calculator show how to select the correct size and type power-drive flexible shafts for any application (maximum capacity 1500 lb-in.). Also given is the necessary data for selecting remote-control flexible shafts (maximum capacity 4000 lb-in.).

400 DIRECT-FIRED HEATERS

National Heater Co.—Bulletin 620, 4 pages, describes National Champion direct-fired heaters, with photographs. A table of capacities for the different sizes and models is included, with dimensions of units. Accessory equipment is shown.

401 VALVES

Kennedy Valve Mfg. Co.—Catalog No. 63, 239 pages, contains full details on Kennedy bronze and iron-body gate, globe, angle, cross, and check valves; malleable, bronze and cast iron fittings; Safetop and standard hydrants; plus complete line of Kennedy valve accessories. Full information on wide range of disk and seat trims available. Cross-section illustrations show all working parts in detail.

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402 ELECTRIC WELD TUBE MILLS

Yoder Co.—68-page book of information on the mechanics as well as the economics of converting coiled strip into welded mechanical tubing, conduit boiler tubes, furniture tubing, etc.; physical properties of products, end uses, output per man hour; materials suited for tube making; scrap losses, welding speeds and power consumption; continuous feeding; formula for strip widths, etc.

403 OIL-HARDENING STEEL

Firth Sterling Steel & Carbide Corp.—Catalog 20-080 describes Chimo, a tough, oil-hardening steel originally developed for tools that resist shock, vibratory stresses, and hold a good cutting edge. Provides complete information about typical analysis, characteristics, heat-treating, etc.

404 SOOT BLOWERS

Diamond Power Specialty Co.—Catalog No. 1014 describes the complete line of Diamond soot blowers for both air and steam cleaning and having manual, air or electric operation. Completely automatic sequential systems are described and their advantages discussed. This catalog also contains some interesting background material indicating that soot is a better insulator than asbestos.

405 DEAERATING HEATERS

Graver Water Conditioning Co.—Bulletin WC-110, "Graver Packaged Deaerating Heater, Spray-Tray Type," describes a package-type heater for smaller boiler plants, completely equipped with all accessories. Bulletin includes a flow diagram and photographs of actual installations as well as internals.

406 SOLENOID PILOT VALVES

Valvair Corp.—A new 8-page illustrated bulletin "P" describes a new Valvair solenoid pilot valve for controlling air, vacuum, oil, and water. Mechanical drawings show 2-way, 3-way, and 4-way, single and double models, with exhaust port plugged for manifold mounting and for other applications. Complete parts are listed for all models, together with parts numbers and designations on drawings.

407 COLD ROLL FORMING

Yoder Co.—Equipment and process of cold roll forming; end uses of its products, advantages, and commercial possibilities. Also auxiliary equipment for curving, coiling, ring-forming, making tubular shapes, perforating, welding, embossing, and other operations which can be incorporated in a continuous high-speed cold-forming production line. 88 pages of descriptions and illustrations.

Your NEW CATALOGS Guide offers readers of MECHANICAL ENGINEERING an opportunity to secure advertisers' latest industrial literature available. In this issue there are 407 items to make selections from. For convenience an index may be found on pages 41 and 42. Select desired catalogs by number, requests limited to 25 catalogs. Fill in coupon on page 42 and mail promptly. *(Must be mailed on or before date given on coupon.)*

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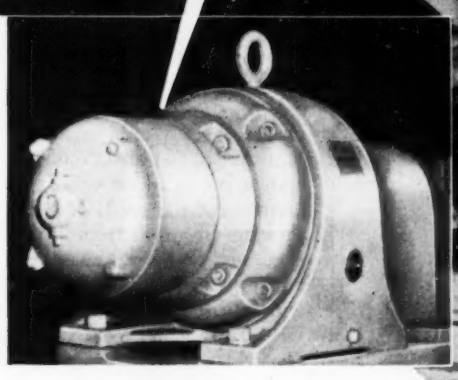
THE Model 10VA, shown, is one of eight models of All American Vibration Fatigue Testing Machines. The "10VA" produces vibration vertically in simple harmonic motion — from 10 to 55 cycles per second on automatic control and from 10 to 60 c.p.s. on manual control. Table load capacity 10 lbs. at 10g. Has 50% overload factor. Tests components, assemblies, products — exposes danger points — forestalls failures in the field. Simple to operate. Essential for today's inspection, testing, research. Send for Bulletin 551.

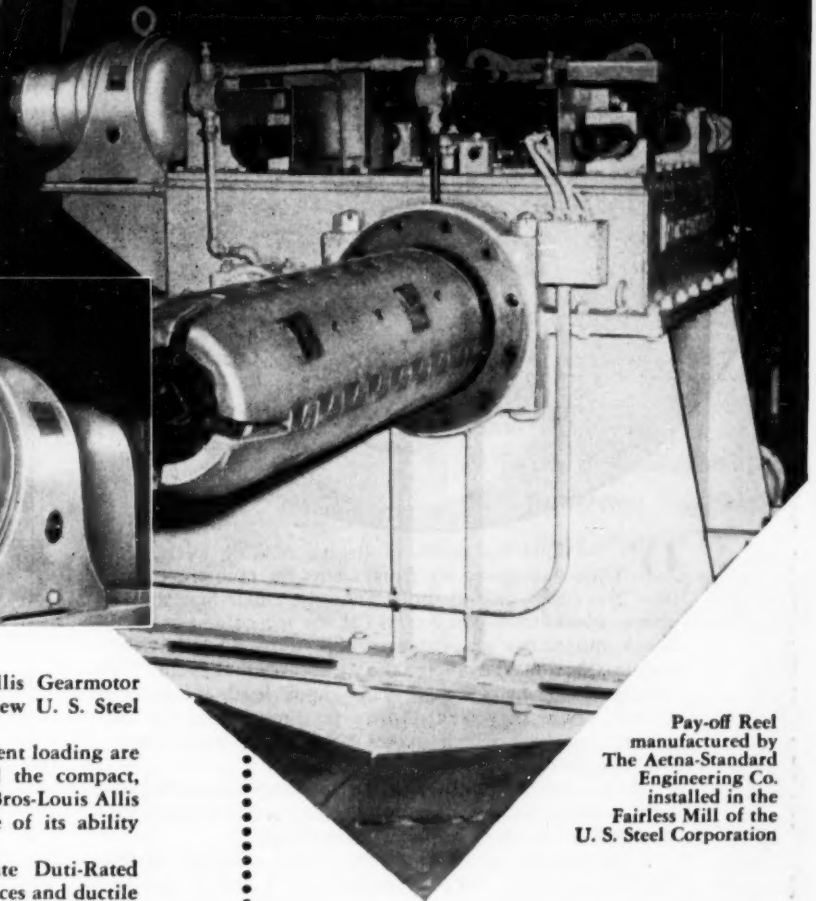
Manufacturers of All American Precision Die Filing Machines.

ALL AMERICAN Tool & Manufacturing Co.

8019 Lawndale Ave. Skokie, Ill.

when a job takes guts here's the gearmotor that has it . . . .





Here's a Foote Bros.-Louis Allis Gearmotor Driving a pay-off reel at the new U. S. Steel Fairless mill.

Rugged service and intermittent loading are characteristics of this job and the compact, low-cost, highly-efficient Foote Bros-Louis Allis Gearmotor was chosen because of its ability to render that service.

These gearmotors incorporate Duti-Rated Gears, with file-hard tooth surfaces and ductile cores, assuring maximum strength with minimum size and weight. Available in single, double and triple reductions, to provide output speeds of 780 down to 7.5 r.p.m.

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard • Chicago 9, Illinois

Pay-off Reel manufactured by The Aetna-Standard Engineering Co. installed in the Fairless Mill of the U. S. Steel Corporation

Hygrade Drives

Line-O-Power Drives

Maxi-Power Drives

FOOTE BROS.

Better Power Transmission Through Better Gears

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Please send me Bulletin GMA containing full information on Foote Bros.-Louis Allis Gearmotors.

Name.....
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Position.....
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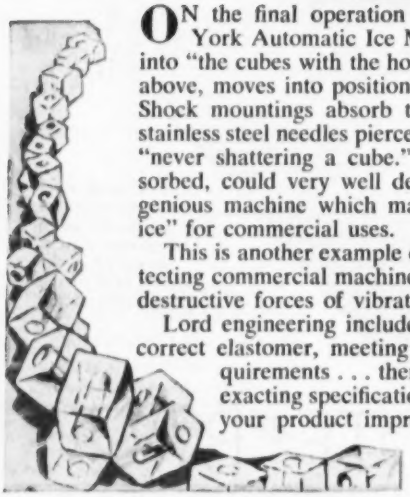
LORD Mountings Absorb Shock OF ICE CUTTING OPERATION IN York refrigeration air conditioning AUTOMATIC ICE MAKER



ON the final operation of its ice making cycle, the York Automatic Ice Maker cuts the columns of ice into "the cubes with the holes." As the cutter bar, shown above, moves into position to cut the ice columns, Lord Shock mountings absorb the initial impact so that the stainless steel needles pierce the ice cleanly and evenly . . . "never shattering a cube." This shock load, if not absorbed, could very well destroy the "magic" of the ingenious machine which makes "Yorkubes" and "York-ice" for commercial uses.

This is another example of the vital importance of protecting commercial machines and their products from the destructive forces of vibration and shock.

Lord engineering includes the careful selection of the correct elastomer, meeting metallurgical and design requirements . . . then manufacturing mountings to exacting specifications. You are invited to discuss your product improvement program with us.

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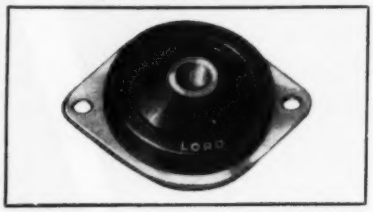
LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER — *Headquarters for* **VIBRATION CONTROL**

Versatility of Lord Mountings Again Demonstrated by York Application

By correct use of the Lord Mounting to absorb initial shock of the stainless steel ice-cutting needles used in the final operating cycle of the York Automatic Ice Maker, Lord Engineering ingenuity demonstrates again its versatility. Lord Plateform Mountings, illustrated below, cushion the impact of the needles to eliminate the danger of shattering the "cube with the hole".



This is but one of a wide variety of installations in which Lord Mountings absorb shock and isolate vibration, protecting machine operation and prolonging service life.

On sensitive instruments and electronic equipment, Lord Mountings are used in a widely diverse pattern of applications. For instance, on airborne radio, radar and instrument panels Lord Mountings prevent vibration from affecting the accuracy of these sensitive mechanisms. Lord Mountings are also widely used on the recording instruments of industry, on farm and construction equipment, automotive and railway equipment.

Lord Flexible Couplings from 1/50th hp. to 100 hp. are used for the transmission of power. A tiny Lord Flexible Coupling transmits the power in home blenders and juicers. A mammoth capacity Lord Flexible Coupling transmits the power of the new Boeing Gas Turbine Engine to the driving wheels of a heavy duty truck, thus demonstrating another example of Lord "advanced design" engineering.

In the sky, on military and commercial aircraft, Lord Engine Mountings are used the world over from small single engine private planes to the military and commercial giants.

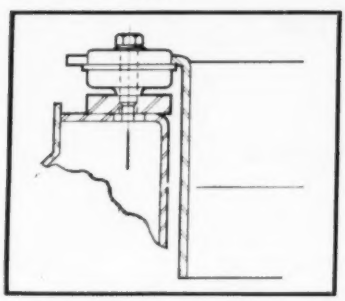
Over 27,000 different designs of Lord Mountings and their variations are available for reference in Lord data files. From this reservoir of design experience, Lord Engineers can help you improve your product.

Lord Mountings Help Reduce "Down-Time" and Service on LeTourneau Earthmover

On "round-the-clock" operations on large construction jobs, "down-time" and service work become expensive to the contractor.

Of necessity, LeTourneau Earthmovers are operated under the most rugged conditions. It was found that rough terrain, rocks and other obstacles damaged radiators and water systems as a result of high shock loads exerted on those component parts.

Lord plate form mountings are now used on the top of the radiator in either horizontal or vertical position, according to the construction characteristics of various LeTourneau Earthmover Models. These are shown below.



The base of the LeTourneau radiator rests on the Lord plate form mounting illustrated below.

This combination results in complete control from any direction, of engine vibration and the heavy shocks encountered in earthmoving operations. Thus, the vitally important cooling system of LeTourneau heavy duty earthmoving equipment is protected by Lord Vibration and Shock Control Mountings. Thus, also, the costly servicing of cooling systems and the resulting "down-time" have been reduced to a minimum.

Further details on the isolation of vibration and absorption of shock loads in other industrial applications are available on request from Lord Manufacturing Company, Erie, Pa.

Protect Radiator on "D" Roadster Tournapull Earthmover by

R. G. LE TOURNEAU INC

Wherever heavy machines change the face of the earth by moving tons and tons of dirt, it's a safe bet that the "D" Roadster Tournapull Scraper is doing a giant's job. Contributing mightily to its continuous, smooth, cool running are the Lord Vibration and Shock Control Mountings which protect the radiator from the shocks this rugged "bear for punishment" must withstand day in and day out. The "D" Roadster's Lord Mountings absorb the twisting, tearing strains of heavy duty earthmoving. The cooling system vital to its uninterrupted operation functions perfectly no matter how rough the going.

Lord Mountings are used profitably by machine designers to protect the most sensitive mechanisms . . . and the most rugged machines. In many instances Lord Engineers help to "design out" malfunctions in machines already operating in a wide diversity of industries. We welcome you to consultation with us on control of vibration and shock.

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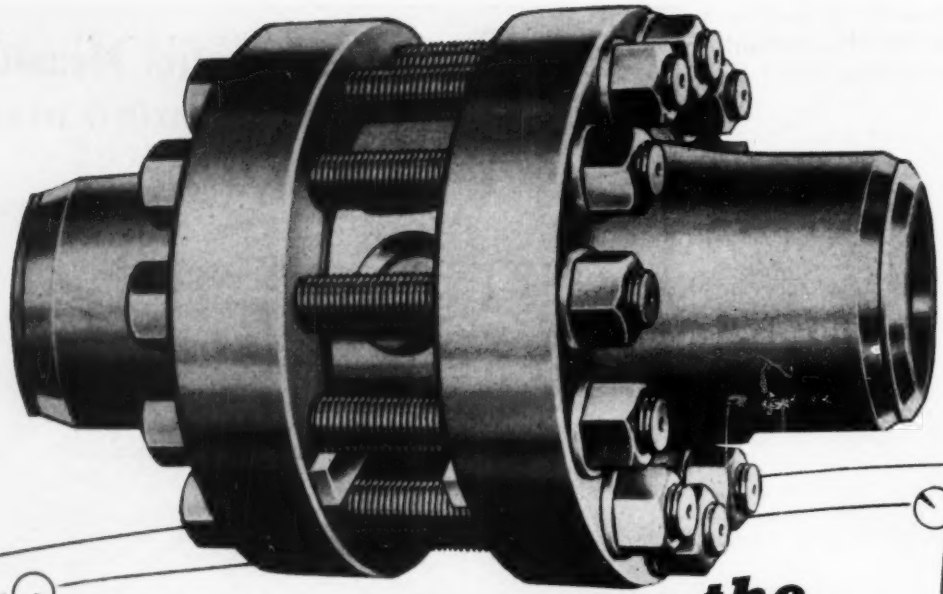
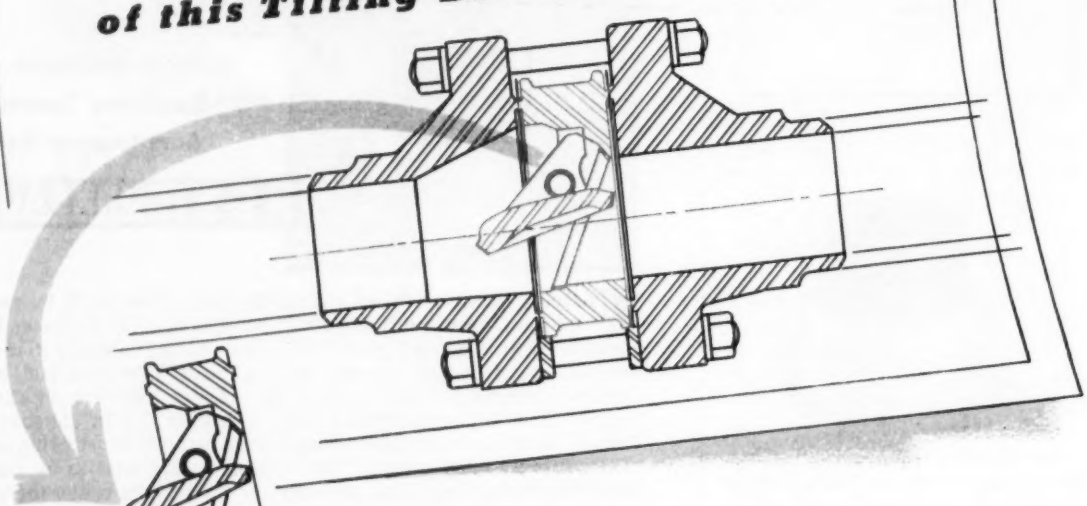


You Can Remove the Center Section

of this Tilting Disc Check Valve



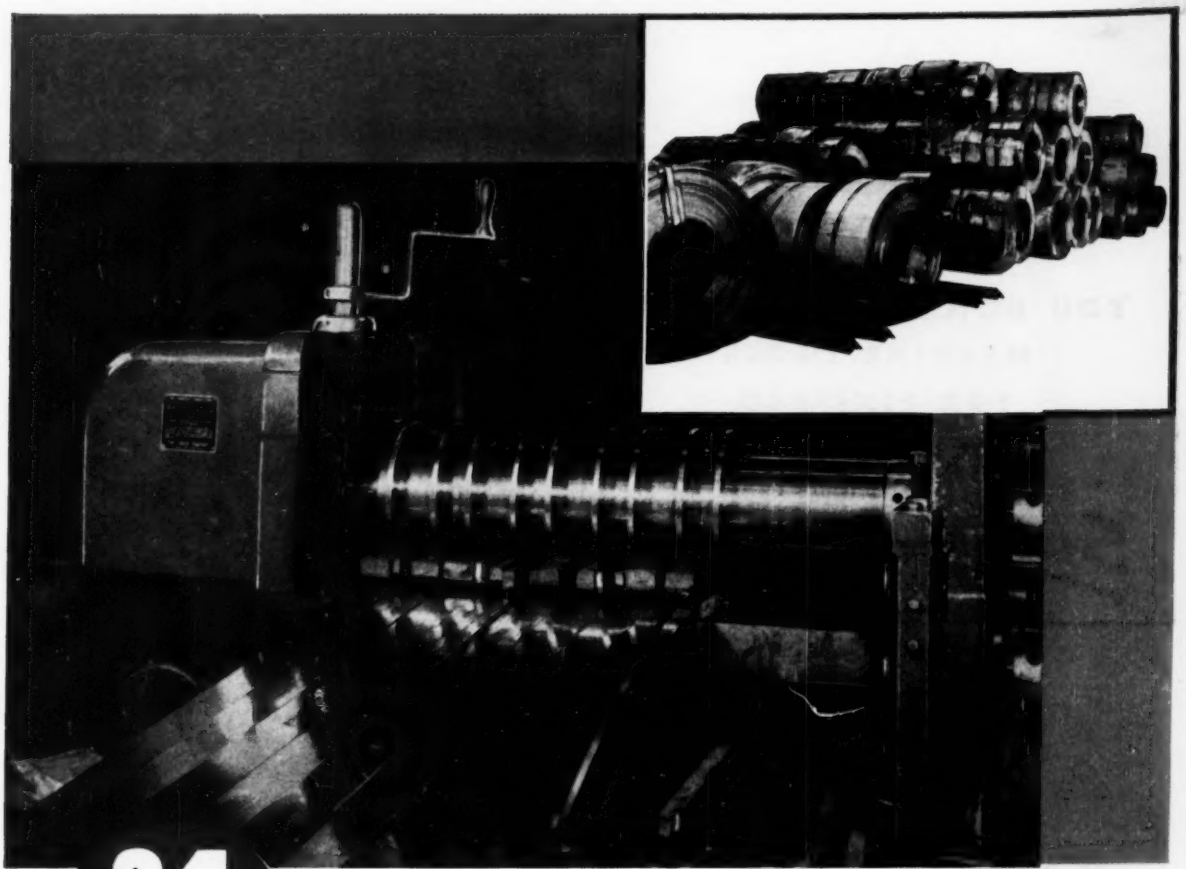
Just take out the studs between the inlet and outlet ends if repairs become necessary. Then the entire center section can be replaced . . . quickly and easily. No need to cut the valve out of a welded line.

The Tilting Disc Check Valve has the advantage of smooth, easy operation because of the balanced disc, which rides steadily and without fluttering in the flow through the lines. In closing, this disc is cushioned to a quiet, droptight seat . . . without any slamming under usual piping arrangements.

Chapman Tilting Disc Valves are also available in the standard two-piece design, in either iron or steel, for all pressures. Write for full details and prices to

The Chapman Valve Mfg. Co.
INDIAN ORCHARD, MASS.

CHAPMAN 3-PIECE (TILTING DISC) **CHECK VALVES**



24 HOUR *Slitting Service!*

If you operate a slitter of your own, you may always enjoy this kind of service. Think what a blessing it is to be able to meet expected and unexpected needs for slit strands on such short notice—how greatly it simplifies production planning—how it eliminates production bottlenecks and minimizes strip inventories.

Then, too, when you buy strip in standard widths, your strip supply sources are more numerous. You buy wherever you get the best delivery, price, and quality.

Slitting service now may cost you anywhere from $10.00 to $100.00 or more per ton. Even if your needs were only 50 tons per month, at an average of $20.00 per ton for slitting, the cost per year would be $12,000.00—an amount which alone may be more than sufficient to make a Yoder slitter highly profitable.

The Yoder Slitter Book (sent on request) analyzes and discusses the economics as well as the mechanics of slitter operation. Yoder engineers will be glad to study your needs and submit recommendations as to kind, size, and cost of suitable slitting equipment.

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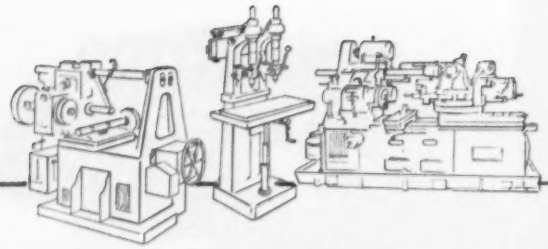

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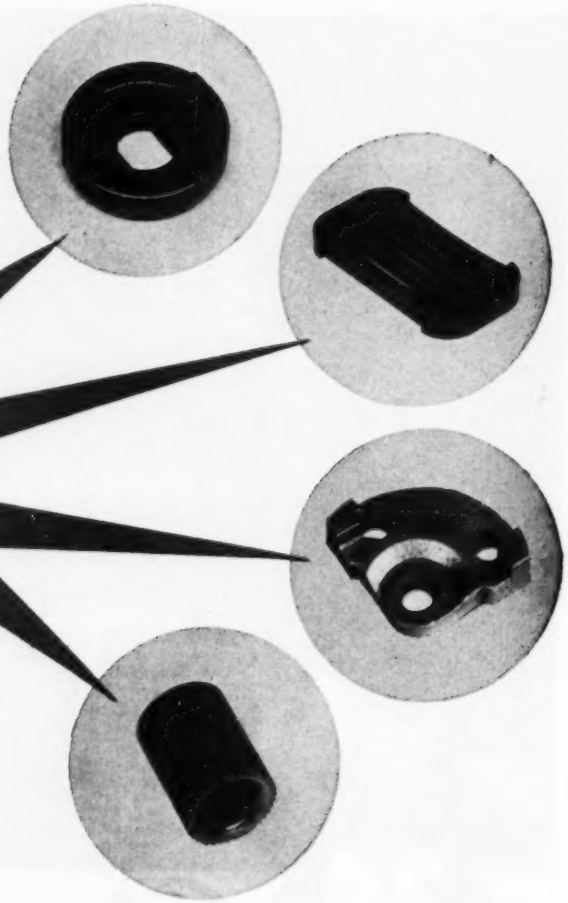

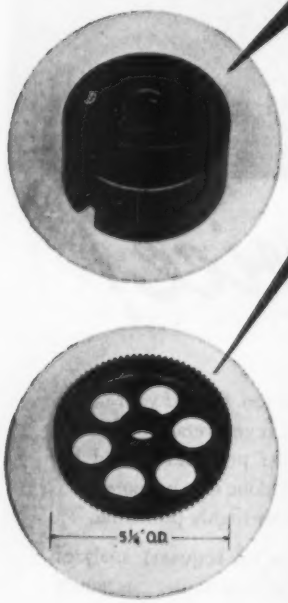

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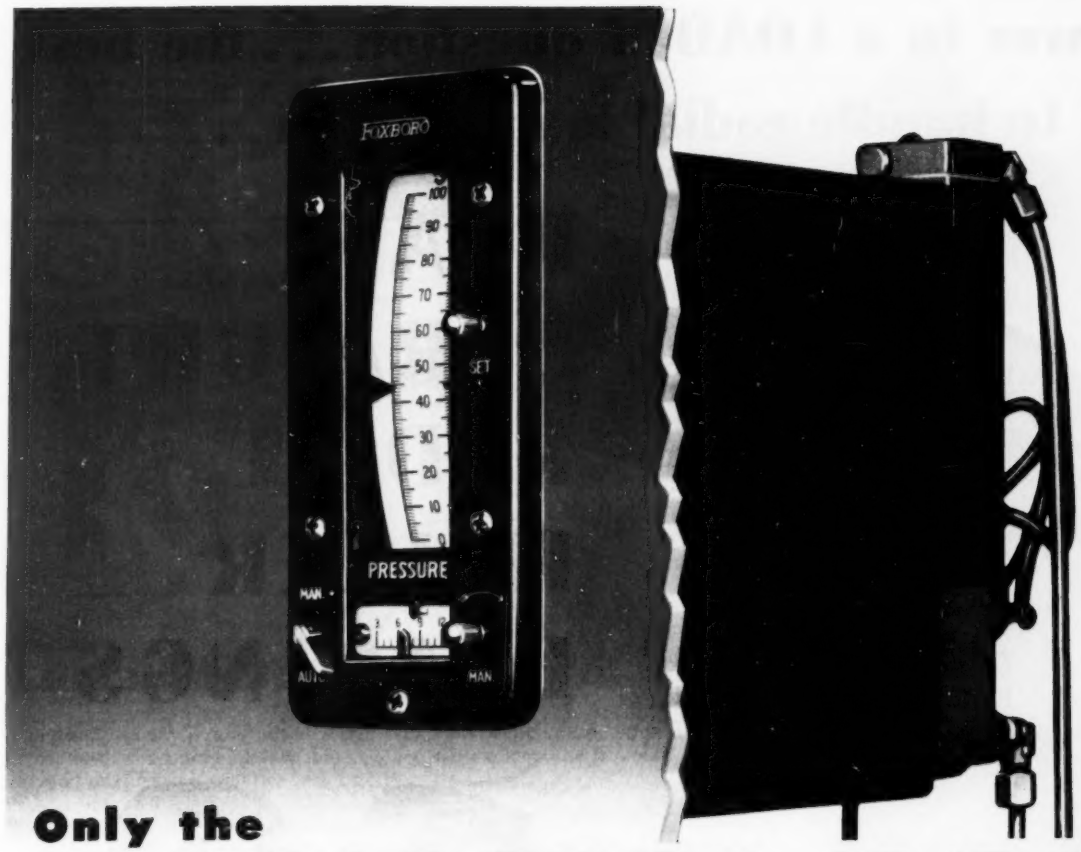

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gives you all these advantages!

For indicating control functions in your console or graphic panel instrumentation, no other controller offers so much for so little money as the Foxboro Consotrol M/52 Indicating Controller. Compare these combined advantages:

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2. **Simple installation** — only 2 connections besides the air supply.
3. **Pull-out feature** that provides complete accessibility of control mechanism from front of panel.
4. **Instrument-type pressure transmitter for driftless** remote manual control, instead of usual pressure regulator.
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6. **Graphic panel compactness** — takes only 3¾" x 7⅞" of panel space.
7. **"Full-size" performance** — control action unsurpassed by the finest conventional-size controllers. Available in Proportional, Proportional with Reset, Proportional with Derivative, Proportional with Reset and Derivative, and On-Off.
8. May be used with separately-mounted recorder using conventional circular charts. Up to 6 records may be combined on one chart with the Foxboro Multi-Record Recorder. (Consotrol Recorder-Controllers, featuring full scale 4" strip charts, also available.)

Get full details of this space-saving, cost-saving instrumentation. Write for Bulletin 463 describing the complete Consotrol Line of graphic panel instruments. **The Foxboro Company, 964 Neponset Ave., Foxboro, Mass., U. S. A.**

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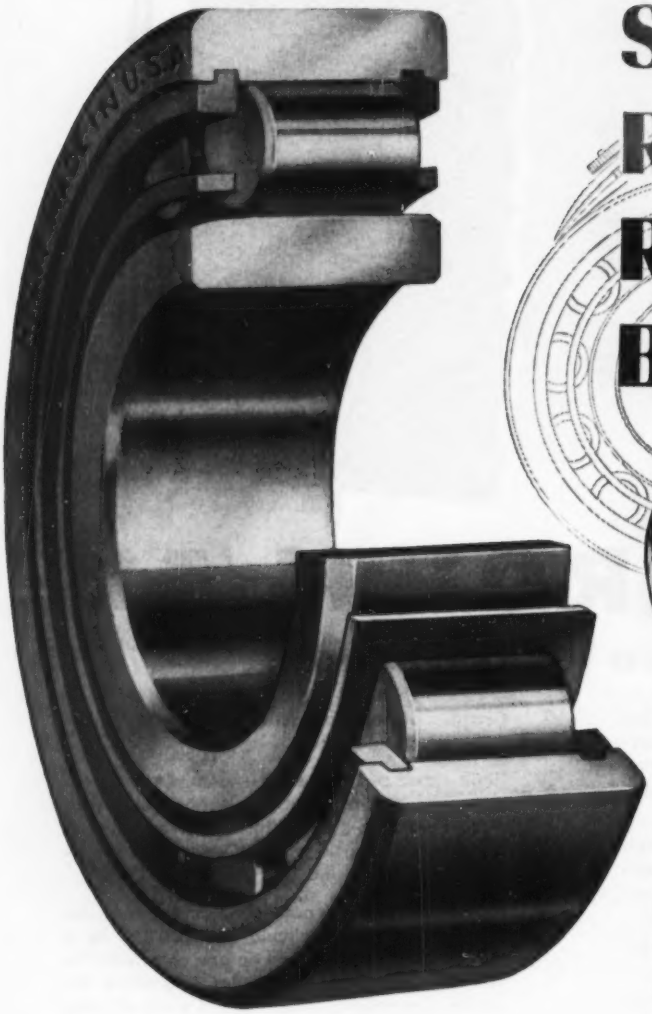
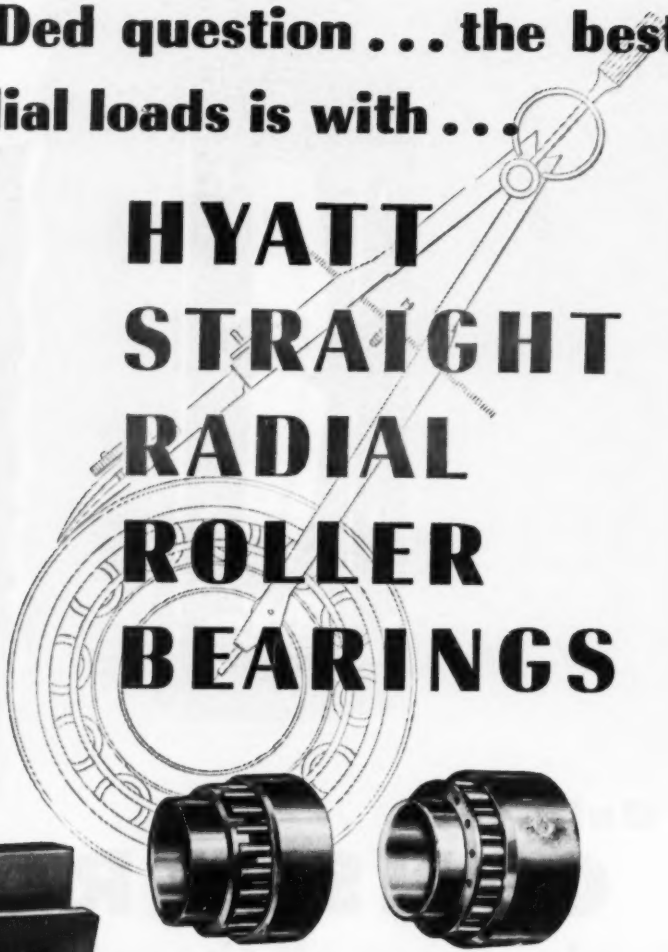
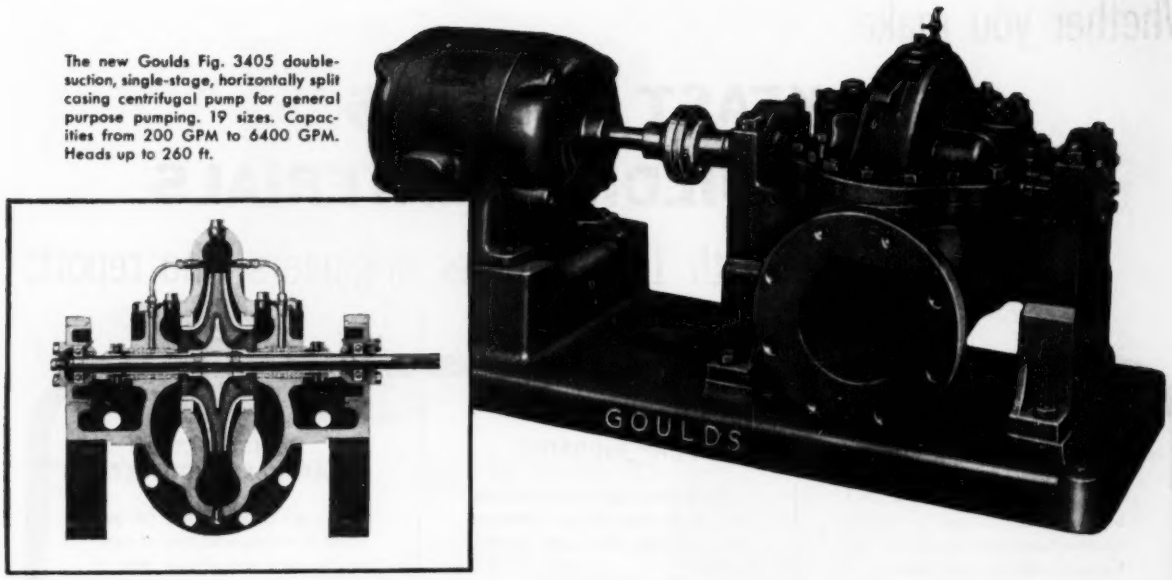




Wherever the jobs . . . and the loads . . . are big, you'll find radial roller bearings smoothing the path of power, because radial roller bearings give the greatest load-carrying capacity within given boundary dimensions. And, whenever radial loads enter the picture, design engineers naturally turn to Hyatt for the most complete line of radial roller bearings available anywhere. The wide range of Hyatt Roller Bearing sizes and types allows the engineer greater design flexibility, makes his job easier. If you are not familiar with the complete Hyatt line, write for our general catalog No. 150. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

The new Goulds Fig. 3405 double-suction, single-stage, horizontally split casing centrifugal pump for general purpose pumping. 19 sizes. Capacities from 200 GPM to 6400 GPM. Heads up to 260 ft.



This new pump gives you 5 big cost advantages

The price you pay is only one element of the cost of a pump installation.

Good engineering practice also figures in the cost of pump breakdowns, low operating efficiency, changeovers to meet new conditions, replacement parts inventories, even the floor space the installation takes up.

Here's why the new Goulds centrifugal pump is designed to improve your cost experience in every one of those elements.

1. ***It combines seven design features that mean maximum operating efficiency and minimum maintenance.***

Every one of these construction features is standard with this new design. Together they offer you, without extra cost, a quality of service that's unique in its approach to general liquid handling.

a. Renewable stuffing box bushings.
b. Bearing housings sealed against moisture and dirt.
c. Cowl-type glands suitable for use with quenching liquids.
d. Stainless steel impeller keys.
e. Teflon water seal rings.
f. Die-formed stuffing box packing.
g. Corrosion resistant gland bolts.

2. ***Interchangeability of parts.***

With only three shaft and rotating parts assemblies to provide for 19 pump sizes and 38 pump combinations, this new design offers you a remarkable range of interchangeable parts. A glance at the interchangeability chart on page 7 of the descriptive bulletin will show you:

a. how this design gives you great flexibility in making field changes should your pumping requirements change;
b. why the first cost of this unit is so low due to standardization in manufacture; and
c. how this interchangeability helps to reduce spare parts inventories.

3. ***Compact construction.***

You will be particularly pleased with the short over-all length of this new design. Short bearing spans cut lengths as much as 50%. This means a real saving in floor space.

4. ***Flexibility of stuffing box.***

You can use either conventional stuffing boxes or mechanical seals depending on requirements. And you can change from one to the other in the field if need be.

5. ***Easy rotation change.***

A unique device, locking shaft sleeves, permits you to change from right-hand rotation to left-hand rotation or vice versa in the field without construction changes.

More than 50 years of experience in meeting industry's needs for general purpose centrifugal pumps come to a climax in this design.

GET FULL DETAILS **This 12-page illustrated bulletin, No. 721.6, covers the complete details of the new Goulds Fig. 3405, including specifications, interchangeability tables and performance curves. Be sure you have the whole cost-advantage story before you select another general purpose pump. Contact your nearest Goulds representative or mail the coupon below today.**

GOULDS PUMPS, INC., Dept. ME, Seneca Falls, N.Y.

Please send me Bulletin No. 721.6 describing the new Fig. 3405 centrifugal pump.

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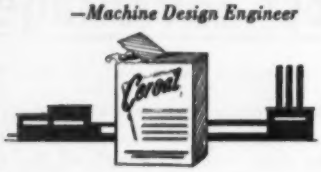

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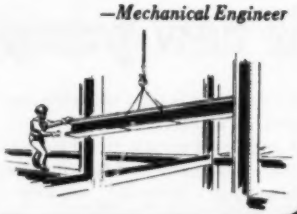

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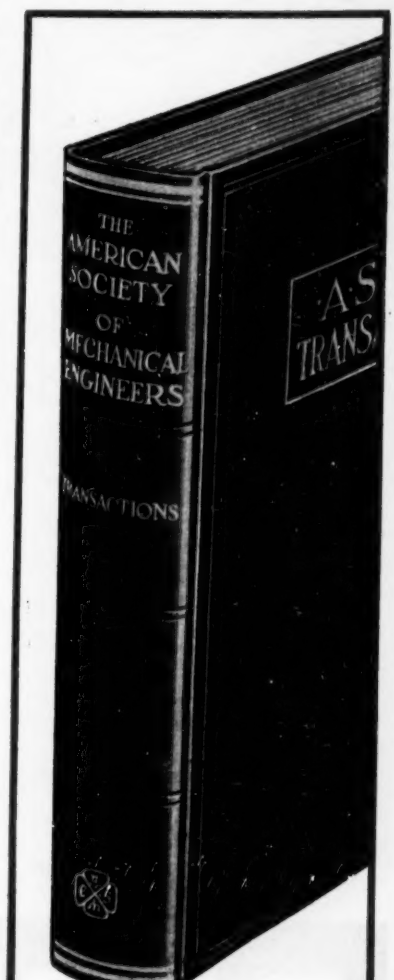

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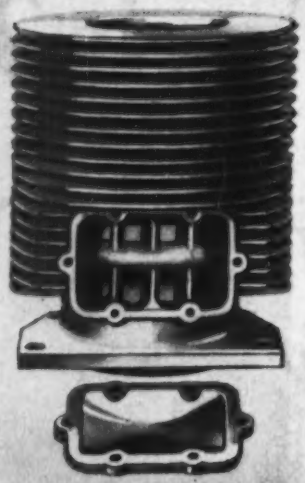

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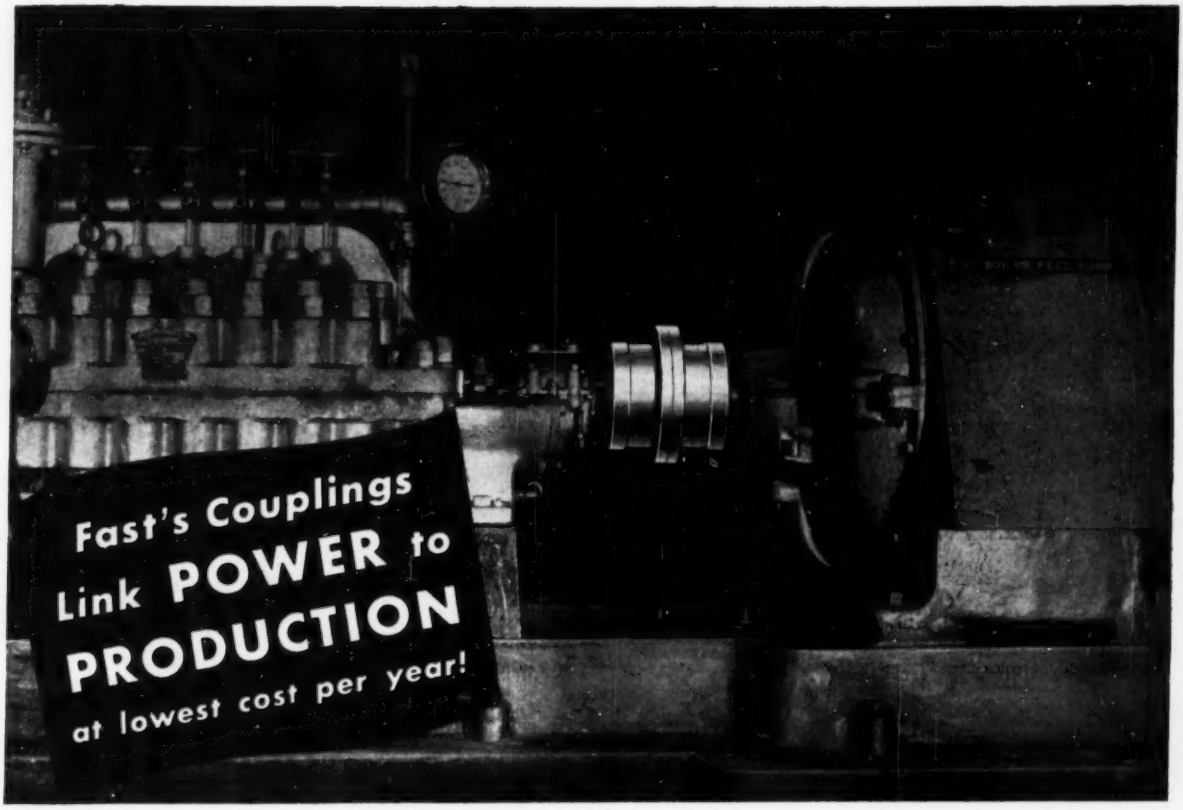

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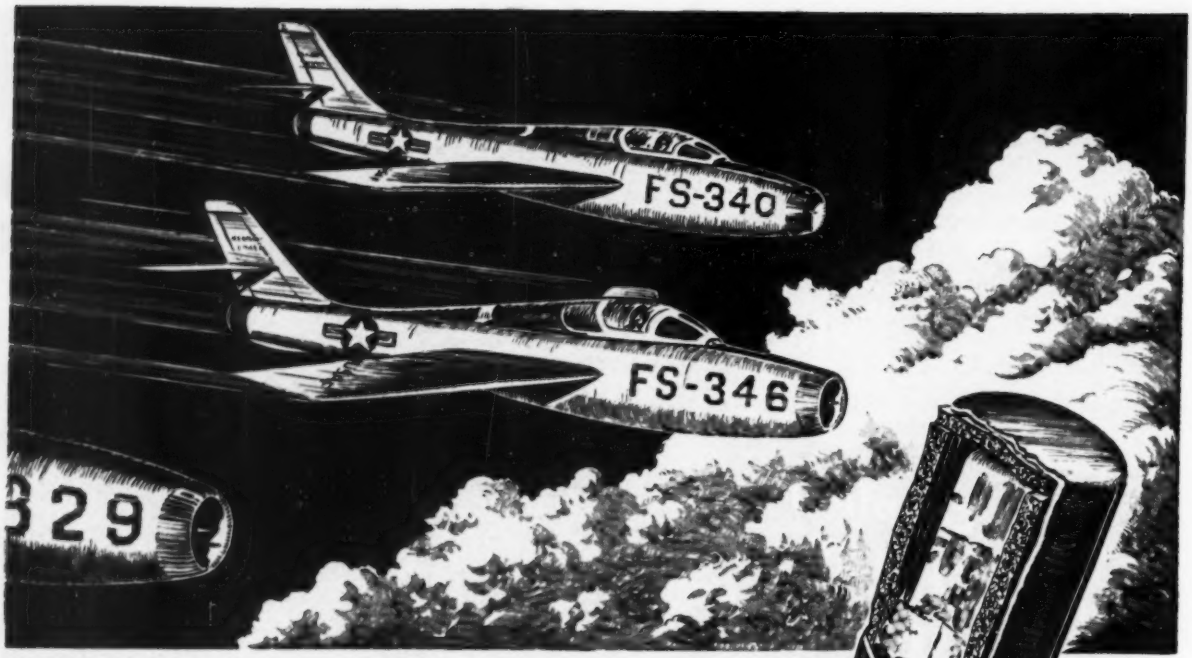

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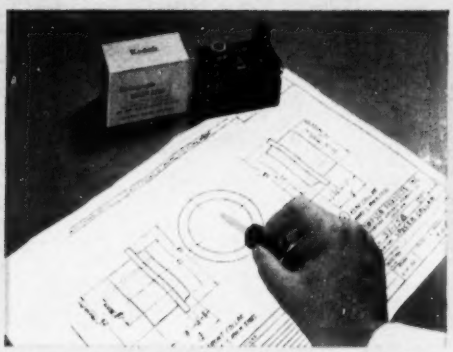
Extremely fine-detailed drawings are reproduced on Kodagraph Autopositive Film, which captures the faintest detail . . . keeps close lines from "filling in". . . and produces top-quality photographic intermediates which have extremely fast print-back speeds.

No negative step . . . no darkroom handling. Kodagraph Autopositive Paper and Film are handled in exactly the same manner . . . produce positive photographic intermediates *directly*. First, they are exposed in one of the Tapco Plant's direct-process machines—or in a photocopy unit. Then, they receive standard photographic processing. A fast, convenient room-light operation all the way. And no new equipment needed.



Autopositive intermediates save creative drafting time. Tapco Plant makes necessary changes in its basic designs without costly redrafting by (1) making Autopositive prints of the original drawing; (2) removing the unwanted detail from the Autopositive reproduction with eradicator fluid. Then, the draftsman has only to add the new detail . . . and a print-making master is ready. *One* which will produce highly legible prints without confusing "ghost" images in the eradicated area.

Autopositive reclaims "unprintables." Many old drawings that have lost line density or are soiled or torn are transformed into print-making masters by reproducing them on Autopositive Paper or Film. Stains and crease marks are dropped out . . . weak detail is made more legible—saving hours of redrafting. Autopositive Paper is also used to duplicate a variety of office records, non-translucent vendor prints, etc.

Kodagraph Autopositive Materials

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1/15 to 3/4 hp d-c motors operating from a-c lines.

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★ *Very fast start-stop-reverse with panel switch*
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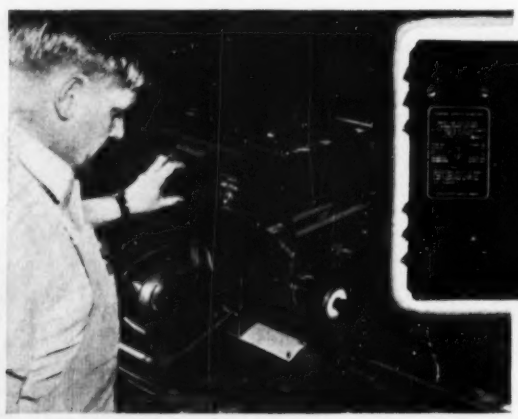
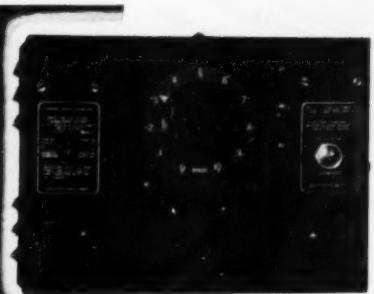
★ *Essentially ripple-free armature current — no pulsating at low speeds*
★ *Simple installation — complete control box can be mounted right at machine — no remote control cabling or auxiliaries needed*
★ *Over-all regulation is 1.5 to 2 times that obtained from operation directly from d-c power lines*





Type 1700-B (¾ and ½ hp) *Variac Motor Speed Control conveniently installed on a resistance-card winding machine for optimum operation.* **Price $160**

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A DIAMOND Cleaning System

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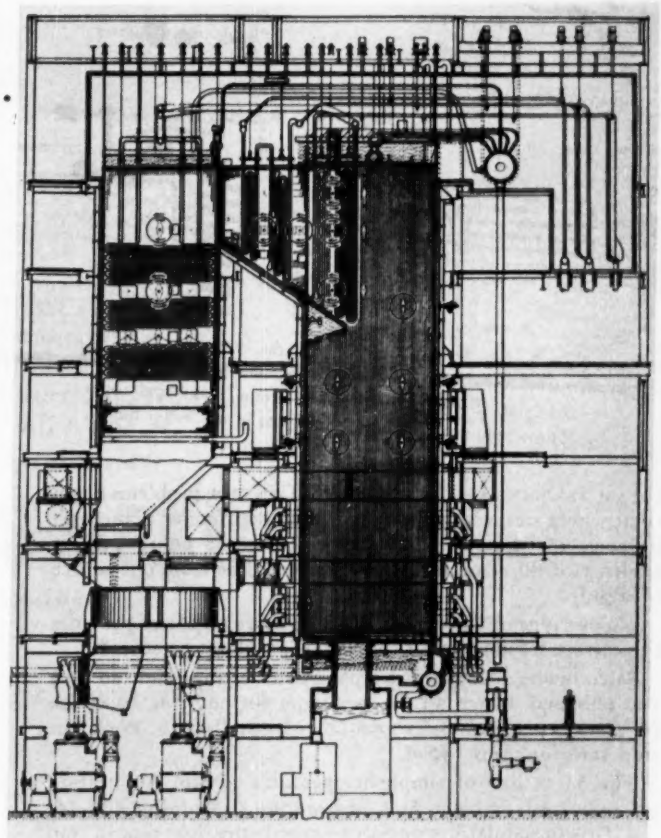

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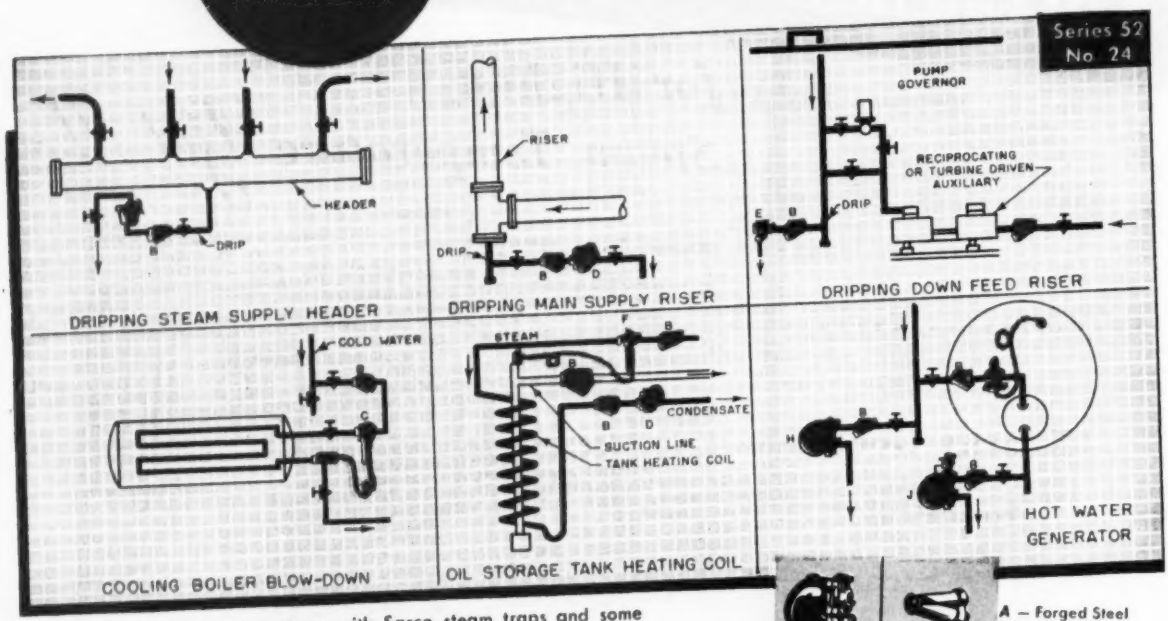
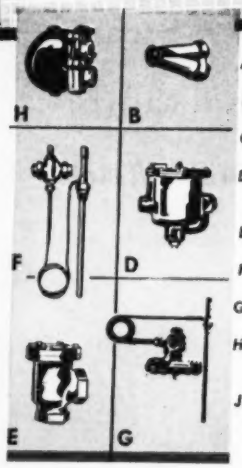
6160

SARCO in the boiler house...



Assuring dry steam with Sarco steam traps and some Sarco temperature control hook-ups in the boiler house.



A — Forged Steel Bucket Trap
B — Pipe Line Strainer
C — Temperature Regulator, TR-19
D — Inverted Bucket Steam Trap
E — Thermostatic Steam Trap
F — Temperature Regulator TR-21
G — Temperature Regulator 24-30
H — Float-Thermostatic Trap, type FTS
J — Float-Thermostatic Trap, type FTD-M

●STEAM TRAPPING AND TEMPERATURE CONTROL problems begin right where steam is generated. The modern boiler plant with its maze of piping and auxiliary equipment offers striking evidence of the advantages of a complete line from one source of supply.

No one type of steam trap or temperature regulator provides the correct solution to all the varied problems presented.

Sarco makes four distinct types of steam traps and can give you unbiased advice on the best type for any job, based on 30 years experience and thousands of installations. ***Write for trap selector chart 145-4.***

The Sarco line of simple temperature control for heating or cooling is complete. ***Full information in Catalog 600-16.***

It pays to standardize on Sarco—exactly the right type of trap or regulator, but all of one make—no divided responsibility!

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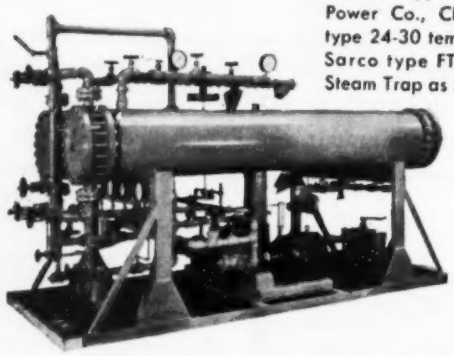
SARCO saves steam
improves product quality and output



Enterprise dual pump set to preheat 3,200 gph of Bunker C fuel oil to 225°F. Supplied by Enterprise Heat & Power Co., Chicago, Ill. with Sarco type 24-30 temperature regulator and Sarco type FTQ Float-Thermostatic Steam Trap as standard equipment.

423

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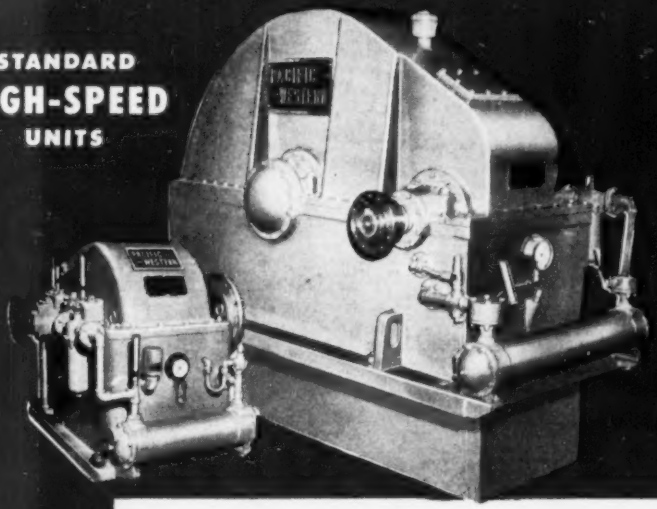
HIGH-SPEED
UNITS



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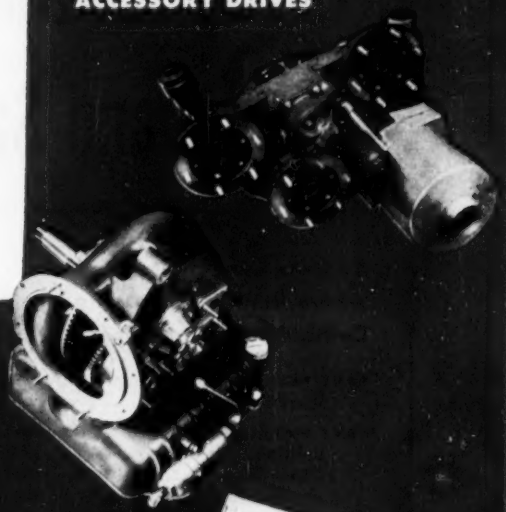

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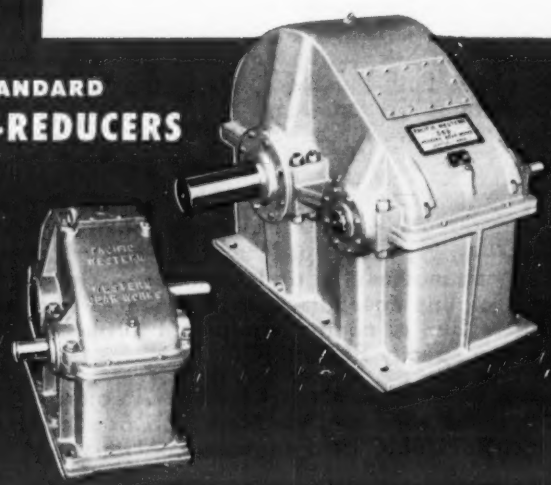

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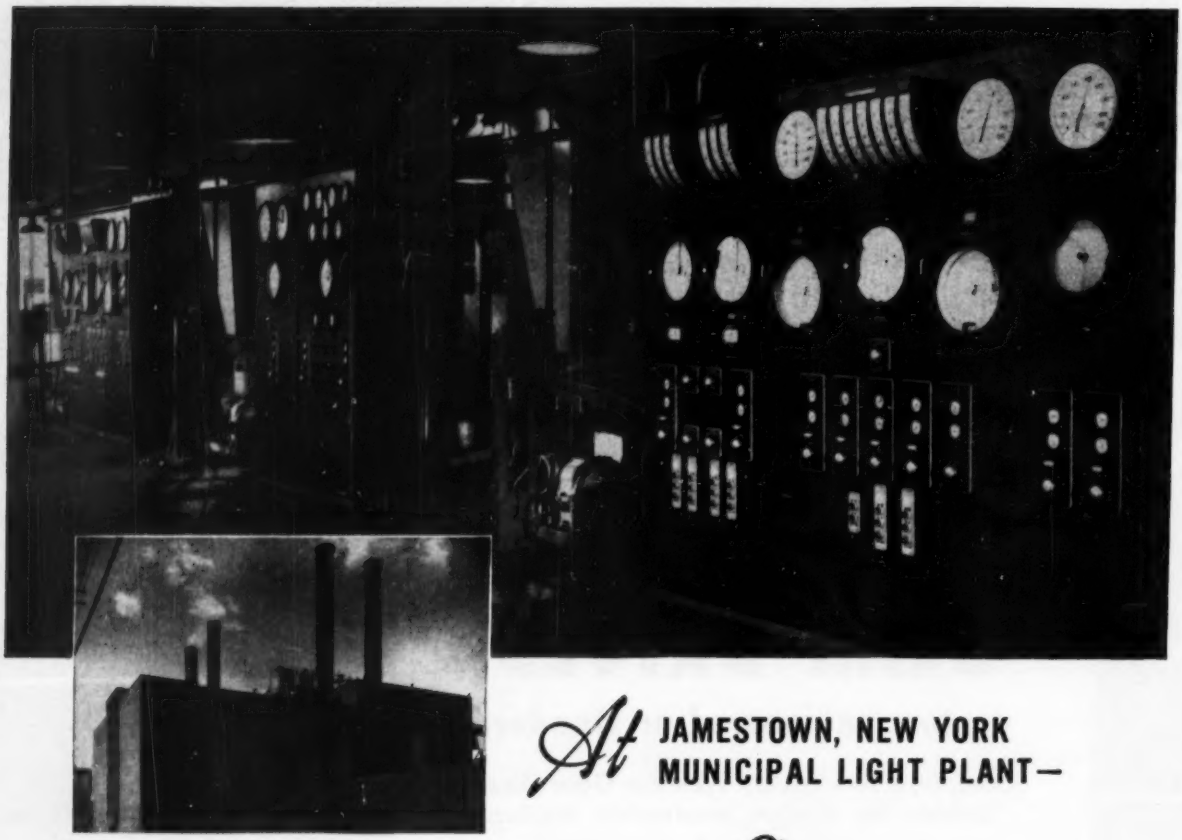

At **JAMESTOWN, NEW YORK MUNICIPAL LIGHT PLANT—**

Control and Savings are *Automatic*

***Another Central Station where* REPUBLIC Automatic Combustion Controls.**

SAVE FUEL by continuously maintaining maximum combustion efficiency.

SAVE MAINTENANCE AND EQUIPMENT by holding uniform operating conditions. Chain-of-event type of trouble that frequently develops as a result of incorrect boiler operation is prevented.

SAVE MANPOWER by automatically performing many repetitive adjustments.

HIGHLY IMPORTANT during this critical power shortage, the Jamestown plant meets peak load demands because, with REPUBLIC Combustion Controls, it gets all of the steam output the plant boilers are rated for.

TWO 150,000 lb. per hr. boilers operating at 900 psig. and 900° F.T.T. supply steam to a 20,000 kw turbine at the Jamestown plant. Steam at 275 psig. and 600° F.T.T. is also supplied through a pressure reducing and desuperheater station to an adjoining older plant. Both the Automatic Control System for the boilers and the pressure reducing and desuperheater station were furnished by REPUBLIC FLOW METERS CO.

For more than 37 years, REPUBLIC has designed and built combustion control systems for all types of boilers—all types of fuel firing—all load conditions and any arrangement of draft equipment. You get the benefit of this specialized experience as well as a complete line of control equipment to choose from when you specify REPUBLIC.

For full information about Republic Automatic Control Systems, send for Data Book S-21 or ask that the nearest REPUBLIC field engineer contact you.

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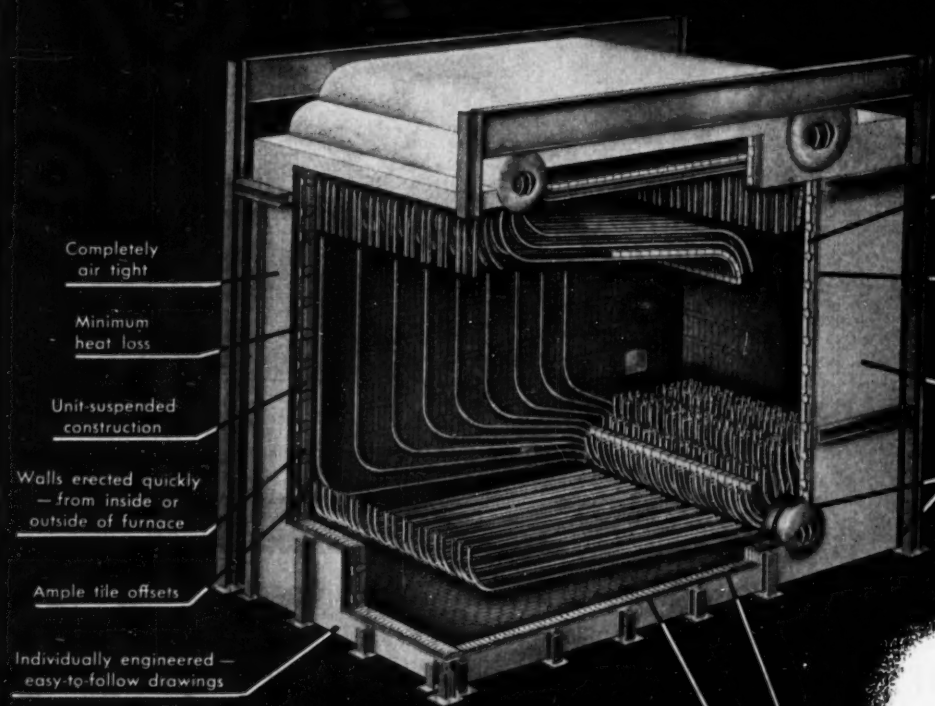
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Link-Belt Research and Engineering . . . Working for Industry

One of man's oldest methods of conveying performs many tasks for modern industry

On this late-model hay baler, Link-Belt Screw Conveyor feeds up to 10 tons of hay per hour to the baling chamber. Below are shown three of many Link-Belt flighting designs.

Helicoid flight conveyor screw

Cut flight conveyor screw

Multiple ribbon flight conveyor screw

LINK-BELT Screw Conveyors feed, elevate, distribute or mix a wide variety of bulk materials

BY refining and specializing Archimedes' 2000-year-old device for moving materials, Link-Belt has made the screw conveyor extremely versatile. Widely used on agricultural machinery, it also performs many functions in industrial plants. And Link-Belt has engineered a range of components for materials of widely varying characteristics.

Whether the product is light or heavy, fine or coarse, granular or flaky, sluggish or free-flowing—Link-Belt can supply the screw conveyor that assures top efficiency. And here, as in every phase of bulk materials handling, Link-Belt offers unequalled experience in applying this and related conveying equipment to your system.

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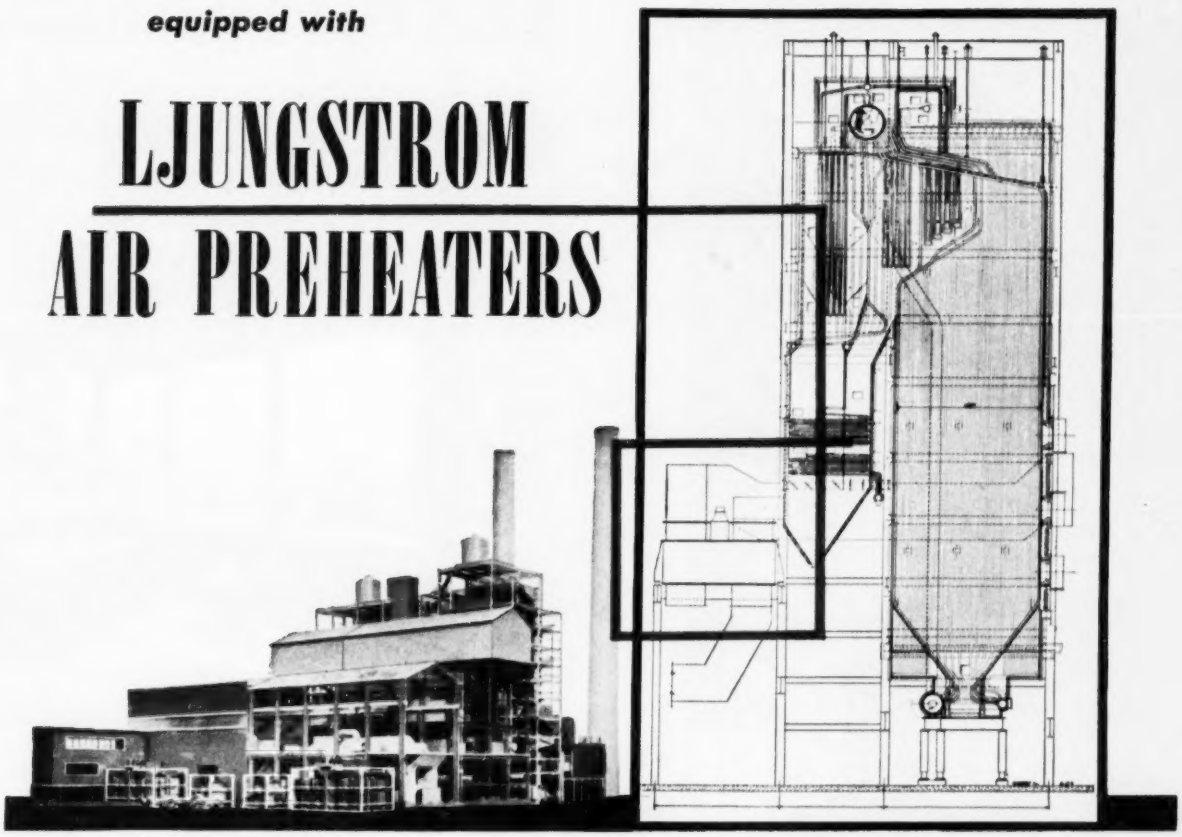
Boilers at new Gadsby Steam Plant of the Utah Power & Light Company . . . .

equipped with

LJUNGSTROM AIR PREHEATERS



Utah Power & Light Company's new Gadsby Steam Plant, designed by Bechtel Corporation, will utilize, on completion, two Riley Steam Generating Units totalling 1,195,000 pounds of steam per hour capacity.

One unit, shown here, went on the line last August. Fired with petroleum pitch and designed for future pulverized coal firing, it generates 620,000 pounds of steam per hour at 1500 psi and 955 F. The second boiler is scheduled to begin operation late this year. Its capacity will be 575,000 pounds of steam per hour. This unit is designed for 1700 psi and 1000 F, with a reheat cycle at 396 psi and 1000 F. It will be fired with pulverized coal, and will have firing equipment for petroleum pitch.

Each of these modern steam generating units has been designed to incorporate a Ljungstrom Air Preheater. The Ljungstrom now in service preheats combustion air to 642 F, cools stack gases to 305 F. The Ljungstrom on the second unit will preheat air to 650 F, cool exit gas to 315 F.

This is another example of the unanimity with which boiler manufacturers have included Ljungstrom Air Preheaters in outstanding recent installations. The effectiveness and dependability of the Ljungstrom Air Preheater have made it a standard for high efficiency steam generating units.

THE Air Preheater Corporation 60 East 42nd St., New York 17, N. Y.

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POWERS CONTROL

another New York landmark equipped with

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Pneumatic System of AIR CONDITIONING CONTROL

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Air conditioning here is by means of a split system — individual units shown below, for the glazed periphery of the building are fed with high pressure filtered and humidified air and heated or chilled water. In the center of the office space high velocity conditioned air is distributed thru ceiling diffusers.

Right-temperatured-air at proper humidity is assured at all times by a Powers pneumatic control system. Only a few of its important controls are shown below, most are "behind the scenes" performing their tasks with unfailing dependability.

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Experience we have gained in many installations such as these may be helpful to you. When problems of temperature or humidity control arise contact POWERS nearest office, there's no obligation.

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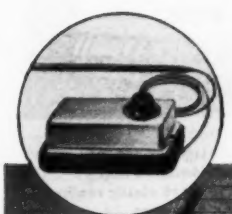
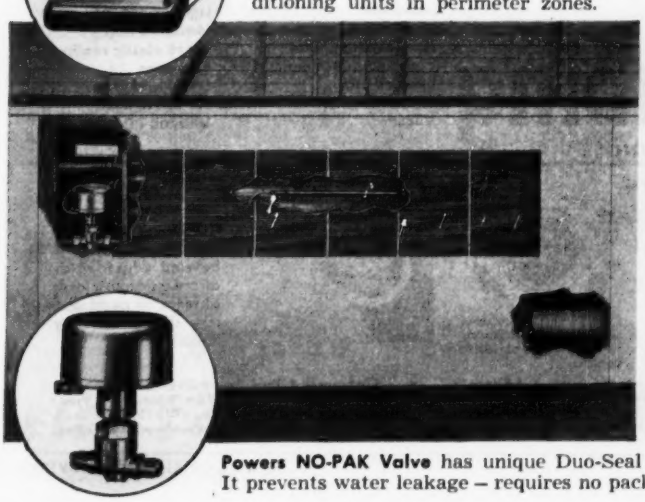
Over 60 Years of Automatic Temperature and Humidity Control

Skokie, Ill., Offices in Over 50 Cities, see your phone book



Powers Summer-Winter Thermostat and No-Pak Valve below, regulate air conditioning units in perimeter zones.



Powers Master Control Panel for primary air and water circuits plays an important part in the efficient regulation of the air conditioning system.

Powers NO-PAK Valve has unique Duo-Seal packless feature. It prevents water leakage – requires no packing maintenance.

(b4)

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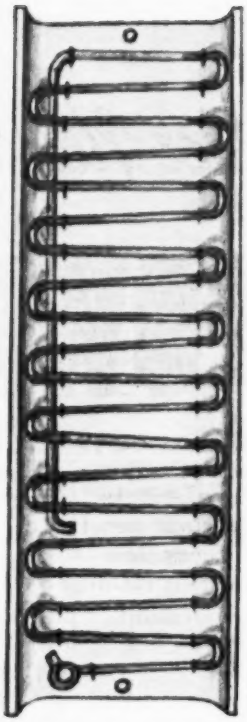
TO jog a designer's imagination

REFRIGERATOR CONDENSER



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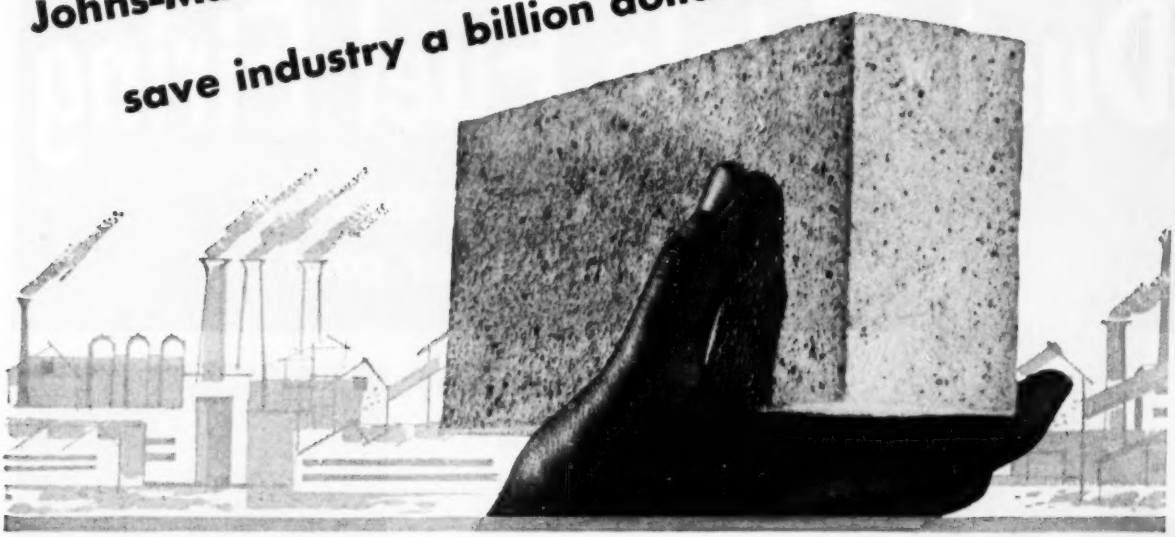
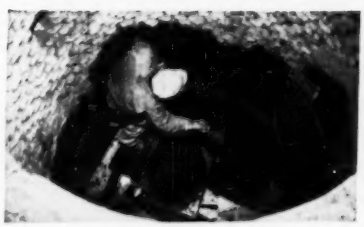
Johns-Manville Insulations save industry a billion dollars in fuel every year!



Reduce your fuel costs and build better furnace linings with JM-3000 INSULATING FIRE BRICK

HERE'S THE ONLY insulating fire brick that withstands a full 3000F. It's highly efficient both as an exposed refractory lining or as back-up insulation. And JM-3000 is only one of six types of Johns-Manville Insulating Fire Brick made for these applications. All provide long-life insulation. All are light in weight, have low conductivity, high structural strength. These properties permit thinner furnace walls—yet you can achieve important fuel savings and increased production, because J-M Insulating Fire Brick assures quick furnace response.

Sil-O-Cel* Insulating Brick is another outstanding J-M fuel-saver . . . a high load-bearing brick for back-up insulation behind refractory linings. It comes in three types, for service through 2500F—makes it possible to reduce the necessary thickness of refractory linings as much as one-third.



Save fuel with J-M Hydraulic Setting Refractories

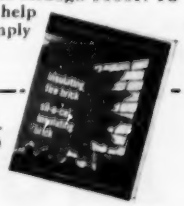
Johns-Manville refractories meet every need for castable, troweling and gunning applications for temperatures through 3000F. *Firecrete** is used to cast special shapes of all kinds. It is ready for use within 24 hours, has negligible shrinkage and high resistance to spalling. *Blazecrete** is used to build and repair furnace linings. When gunned, it adheres readily with a minimum of rebound loss. When slap-troweled, it eliminates laborious ramming and tamping.

Save Fuel with J-M Aggregates and Fills

These lightweight insulations are used as fills to conserve heat in irregular spaces where other forms of insulations cannot be economically applied. They are also used as aggregates for mixing with other materials to form insulating refractory concrete.

*Reg. U. S. Pat. Off.

Send for your free copy! This new booklet IN-115A gives full details about J-M insulating materials for service through 3000F. To find out how they can help cut your fuel costs, simply mail coupon.



JOHNS MANVILLE JM PRODUCTS

Johns-Manville FIRST IN INSULATION

Johns-Manville, Box 60, N.Y. 16, N.Y.
(In Canada, 199 Bay St., Toronto 1, Ont.)
Please send me, without charge, copy of brochure IN-115A

Name_____

Company_____

Street_____

City & Zone_____ State_____

Iron Fireman

Dual or Triple Fuel Firing

changes fuels quickly fires oil, gas or coal

Central of Georgia Railway cuts steam costs 37%— saves $16,939 a year

J. H. Grayson, Shop Engineer,
Central of Georgia Railway Company

"WE LIKE TO SAVE MONEY and Iron Fireman firing has shown us the way to do it," says Mr. Grayson. "The first year we installed Iron Fireman Industrial Gas Burners with Iron Fireman Pneumatic Spreader stokers as standby firing we saved nearly $12,000 on fuel. In addition, we also saved over $5,000 on labor costs and I can honestly say we enjoy steadier firing, improved operation, and constant steam pressure 24 hours a day."

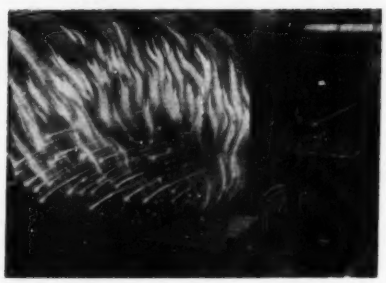
Burns all fuels efficiently

Efficiency ratings are high with oil, gas or coal. As price advantage shifts from one fuel to another your steam plant can shift with it—for the long pull if necessary. Or you can change fuels every day when desirable. This is routine practice in many companies where the gas supply is reduced during peak periods.

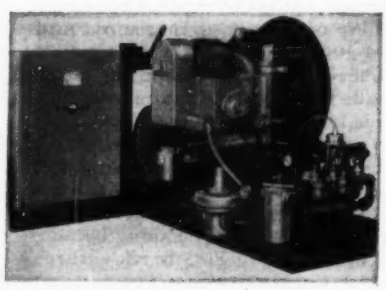
Avoid costly shut-downs

Fuel emergencies, due to interrupted or short supply, can be disastrous. Yet protection may cost little or nothing when offset by the fuel and labor savings of Iron Fireman multiple fuel firing.

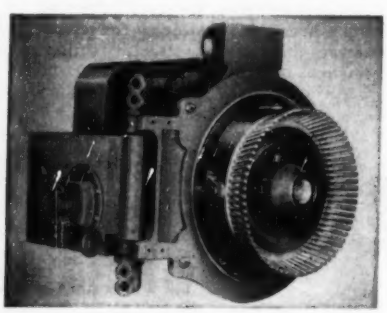
For further information write Iron Fireman Mfg. Co., 3060 West 106th Street, Cleveland 11, Ohio.



GAS, OIL, COAL. Equipment includes Ring Type gas burner, Rotary oil burner, and Pneumatic Spreader stoker. Coal is automatically dried, preheated and conveyed from bunker to boiler. No manual handling; no costly conveying equipment.



GAS-OIL PACKAGE UNIT. For Scotch marine and other types of boilers. Has integral forced draft and control panel which is completely wired and tested at factory.

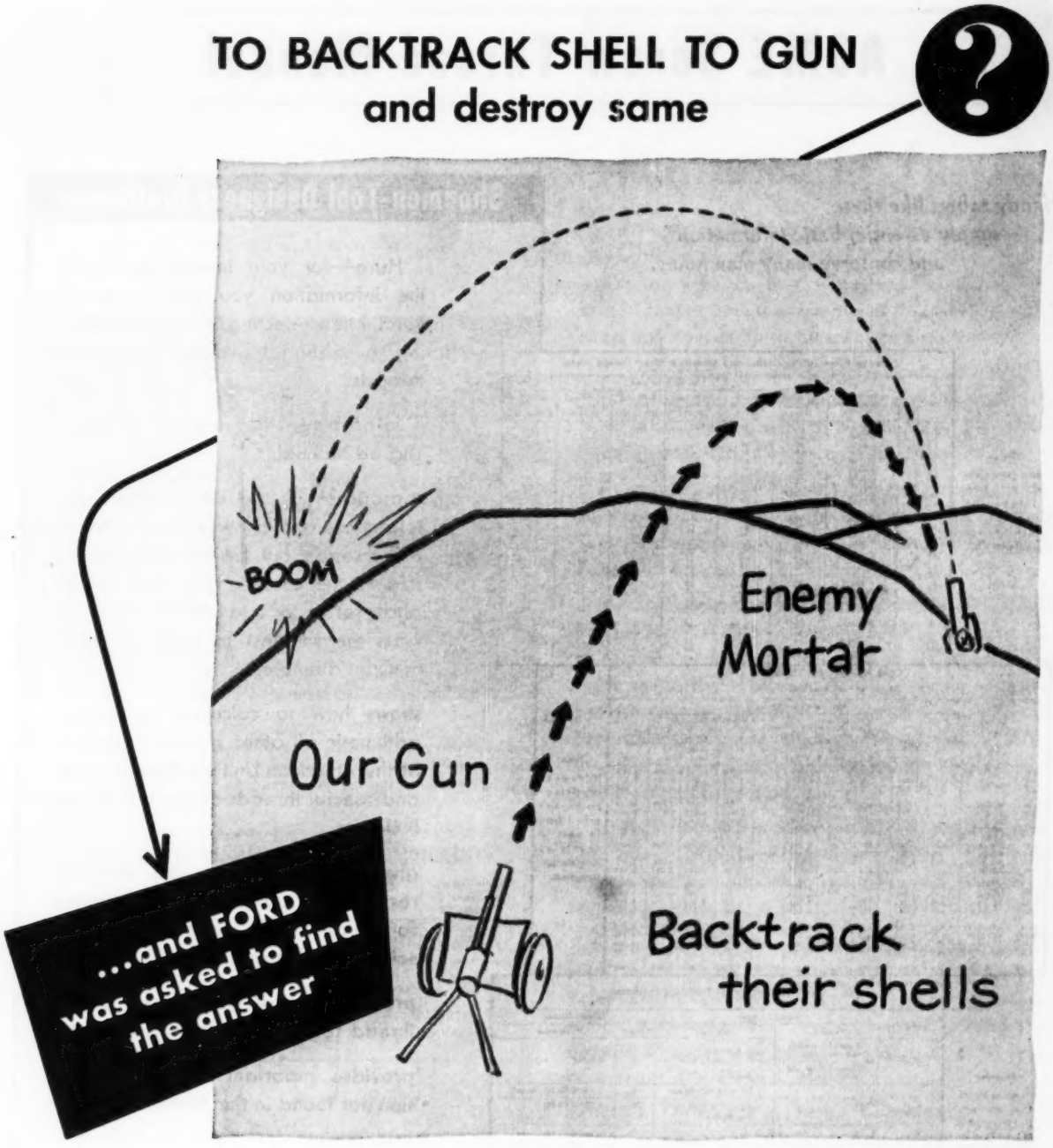


GAS-OIL BURNER. Ring Type gas burner and Rotary oil burner on single mounting. Can shift fuels quickly with no loss of efficiency.

Iron Fireman

AUTOMATIC FIRING
FOR HEATING, PROCESSING, POWER

TO BACKTRACK SHELL TO GUN
and destroy same



Can projectiles be "seen" approaching and their flight backtracked to locate the mortar or gun that fires them? This problem was simply reconciled with special computing equipment designed to be built right into the gun. The engineering of such a computer, the handling of such ballistic data, all falls into the pattern of previous Ford achievements.

This is typical of the problems that Ford has solved since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic electro-mechanical, magnetic and electronic instruments that bring us our "tomorrow" today. Control problems of both Industry and the Military are Ford specialties.

You can see why a job with Ford Instrument Company offers a challenge to young engineers. If you qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

6

FORD INSTRUMENT COMPANY
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

ASME Screw Thread Manual

Handy tables like these supply essential basic information and conserve many man hours.

Shows at a glance the available pitches of standard threads for each diameter.

Index by Diameters to Unified and American Screw Thread Series

Size	Basic Major Diameter	Threads per inch: Coarse (UNC or NC)‡	Fine* (UNF or NF)‡	Extra fine† (UNEF or NEF)‡	8-Thread series (UN or N)‡	12-Thread series (UN or N)‡	16-Thread series (UN or N)‡
0	0.0600	—	80	—	—	—	—
1	0.0730	64	72	—	—	—	—
2	0.0860	56	64	—	—	—	—
3	0.0990	48	56	—	—	—	—
4	0.1120	40	48	—	—	—	—
5	0.1250	40	44	—	—	—	—
6	0.1380	32	40	—	—	—	—
8	0.1640	32	36	—	—	—	—
10	0.1900	24	32	—	—	—	—
12	0.2160	24	28	32	—	—	—
1/4	0.2500	20	28	32	—	—	—
5/16	0.3125	18	24	32	—	—	—
3/8	0.3750	16	24	32	—	—	—
7/16	0.4375	14	20	28	—	—	—
1/2	0.5000	13	20	28	—	12	—
9/16	0.5625	12	18	24	—	12	—
5/8	0.6250	11	18	24	—	12	—
11/16	0.6875	—	—	24	—	12	—
3/4	0.7500	10	16	20	—	12	16
13/16	0.8125	—	—	20	—	12	16
7/8	0.8750	9	14	20	—	12	16
15/16	0.9375	—	—	20	—	12	16
1	1.0000	8	12, 14	20	8	12	16
1 1/16	1.0625	—	—	18	—	12	16
1 1/8	1.1250	7	12	18	8	12	16
1 3/16	1.1875	—	—	18	—	12	16
1 1/4	1.2500	7	12	18	8	12	16

Class 2A—External Threads

(Metric Equivalent of Table 18)

Designation		Allowance	External Thread Limits of Size: Major Diameter Limits Max	Major Diameter Limits Min*	Major Diameter Tolerance†	Pitch Diameter Limits Max	Pitch Diameter Limits Min	Pitch Diameter Tolerance	Minor Diameter Max
		mm	mm	mm	mm	mm	mm	mm	mm
0-80	NF-2A	0.013	1.511	1.430	0.081	1.306	1.260	0.046	1.123
1-64	NC-2A	0.013	1.839	1.743	0.097	1.591	1.535	0.056	1.351
1-72	NF-2A	0.013	1.839	1.770	0.069	1.610	1.562	0.048	1.407
2-56	NC-2A	0.015	2.169	2.068	0.101	1.874	1.821	0.053	1.613
2-64	NF-2A	0.015	2.169	2.073	0.096	1.913	1.862	0.051	1.681
3-48	NC-2A	0.018	2.497	2.383	0.114	2.154	2.096	0.058	1.847
3-56	NF-2A	0.018	2.497	2.393	0.104	2.202	2.146	0.056	1.941
4-40	NC-2A	0.020	2.828	2.695	0.133	2.433	2.370	0.063	2.062
4-48	NF-2A	0.018	2.827	2.713	0.114	2.484	2.423	0.061	2.177
5-40	NC-2A	0.020	3.155	3.025	0.130	2.743	2.677	0.066	2.375
5-44	NF-2A	0.018	3.157	3.038	0.122	2.781	2.718	0.063	2.469
6-32	NC-2A	0.020	3.480	3.333	0.182	2.969	2.898	0.071	2.512
6-40	NF-2A	0.020	3.481	3.351	0.130	3.073	3.007	0.066	2.705
8-32	NC-2A	0.023	4.143	3.990	0.153	3.627	3.553	0.074	3.179
8-36	NF-2A	0.020	4.145	4.006	0.139	3.680	3.617	0.071	3.279
10-24	NC-2A	0.025	4.801	4.610	0.192	4.112	4.028	0.084	3.683
10-32	NF-2A	0.023	4.803	4.651	0.152	4.297	4.231	0.076	3.880
12-24	NC-2A	0.025	5.461	5.270	0.191	4.775	4.686	0.087	4.313
12-28	NF-2A	0.025	5.461	5.296	0.165	4.872	4.790	0.082	4.369
1/4-20	UNC-2A	0.020	6.322	6.116	0.012 0.206	0.310	5.695	5.603	0.094	4.763

Helps interpret specifications received from or sent to countries using the metric system.

Unified Screw Thread Tolerance Formulas

Dimension	External Threads: Class	External Threads: Tolerance	Internal Threads: Class	Internal Threads: Tolerance
Major	1A and 2A centerless hot rolled material	$0.09\sqrt{p}$	All	0.010p**
	2A semi-finished and finished and 3A	$0.06\sqrt{p}$		
Pitch	1A	1.300 × 2A PD tolerance	1B	1.950 × 2A PD tolerance
	2A	$0.0015\sqrt{D} + 0.0015\sqrt{L_e} + 0.015\sqrt{p}$	2B	1.300 × 2A PD
	3A	0.750 × 2A PD	3B	0.975 × 2A PD
Minor	All	PD tolerance + $0.072p$*	All	$0.05\sqrt{p} + 0.03\ p/D - 0.002$ in.†

Notes: Class 1A and Class 2A have an allowance 0.30 × Class 2A pitch diameter tolerance which is applied to the major pitch and minor diameters of the bolts.

* Not normally specified. In practice, it is permissible for a new tool to cut to a p/8 flat at the root of an external thread and to be used until the work produced is rejected by gaging minus representing maximum metal condition of the internal thread.

** Not normally specified. In practice, it is permissible for a new tool to cut to a p/16 flat at the root of an internal thread and to be used until the work produced is rejected by gaging means representing maximum metal condition of an external thread having no allowance.

† If formula gives a greater value, use 0.29p; if it gives a smaller value for 80 to 13 threads per inch, inclusive, use 0.23p − 1.5p², or for 12 threads or coarser, use 0.12p.

Provides formulas for all the major, pitch, and minor diameters for the six unified classes.

Shopmen-Tool Designers-Draftsmen

Here—for your immediate use is the information you must have at hand when selecting, designing, making, or testing the most used screw threads.

In 68 pages this new ASME Screw Thread Manual:

reproduces all the basic dimensions, tolerances and allowances for standard threads, *but restricts the limits of size* to the coarse, fine, and the 8-pitch series of classes 2A and 2B from the smallest to those of 1½" nominal diameter,

shows how to calculate by simple arithmetic all other standard threads of the American Unified Thread series and special threads of the new A and B classes,

gives gage limits of size similarly restricted in range with an example for calculating the omitted limits of seldom used gages,

presents concise descriptions of the thread features and applications,

provides important related information not found in the Standards.

You can rely on this Manual to supply all normal demands and for help in calculating unusual problems without recourse to the Standards.

The American Society of Mechanical Engineers
29 W. 39th St., New York 18, N. Y.

1953 $2.50 (20% discount to ASME members)

FARVAL—*Studies in Centralized Lubrication*
No. 140

800 miles of pipe rolled on Baldwin Bending Roll lubricated by Farval

THIS first of a new type bending roll formed over 800 miles of 24″ and 30″ O.D. pipe its first operating year. At work in a large southern pipe mill, it shapes 31½ foot lengths of 78″ and 97″ skelp at rolling speeds up to 60 feet per minute.

To insure that the new design features for increased production would not be hamstrung by old-fashioned hand lubrication, the machine builder equipped the bending roll with Farval centralized lubrication.

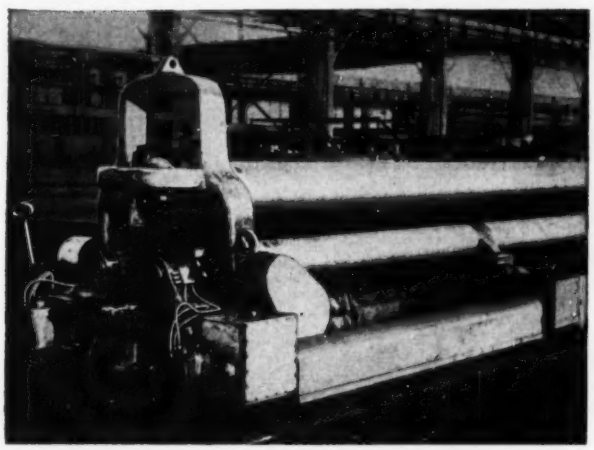
At a single stroke Farval lubricates 62 main bearings on which depends the rugged job of shaping skelp. No stopping for time-consuming hand oiling! Lubricant savings run as high as 75%.

Farval is the original Dualine system of centralized lubrication that delivers oil or grease under pressure to a group of bearings from one central station, in exact quantities, as often as desired. The Farval valve has only two moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Indicators at every bearing tell that each valve has functioned.

Machinery builders and customers alike recognize that Farval centralized systems of lubrication save time, money and lubricant, as well as eliminate bearing expense and increase machine production.

There are Farval systems for your machines, big or small, with proportionate savings. And there's a Farval engineer near you, ready to solve your lubrication problems. Write for full details. Send for Bulletin 25 today. The Farval Corporation, 3264 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



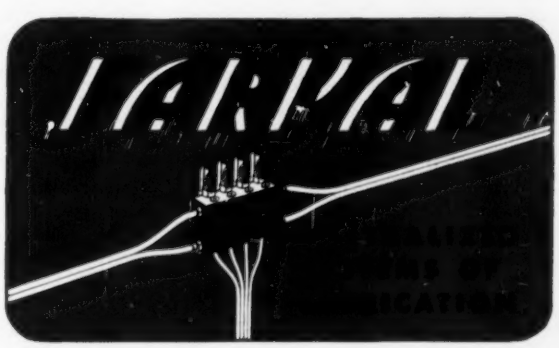
KEYS TO ADEQUATE LUBRICATION— *Wherever you see the sign of Farval—the familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine is being properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.*

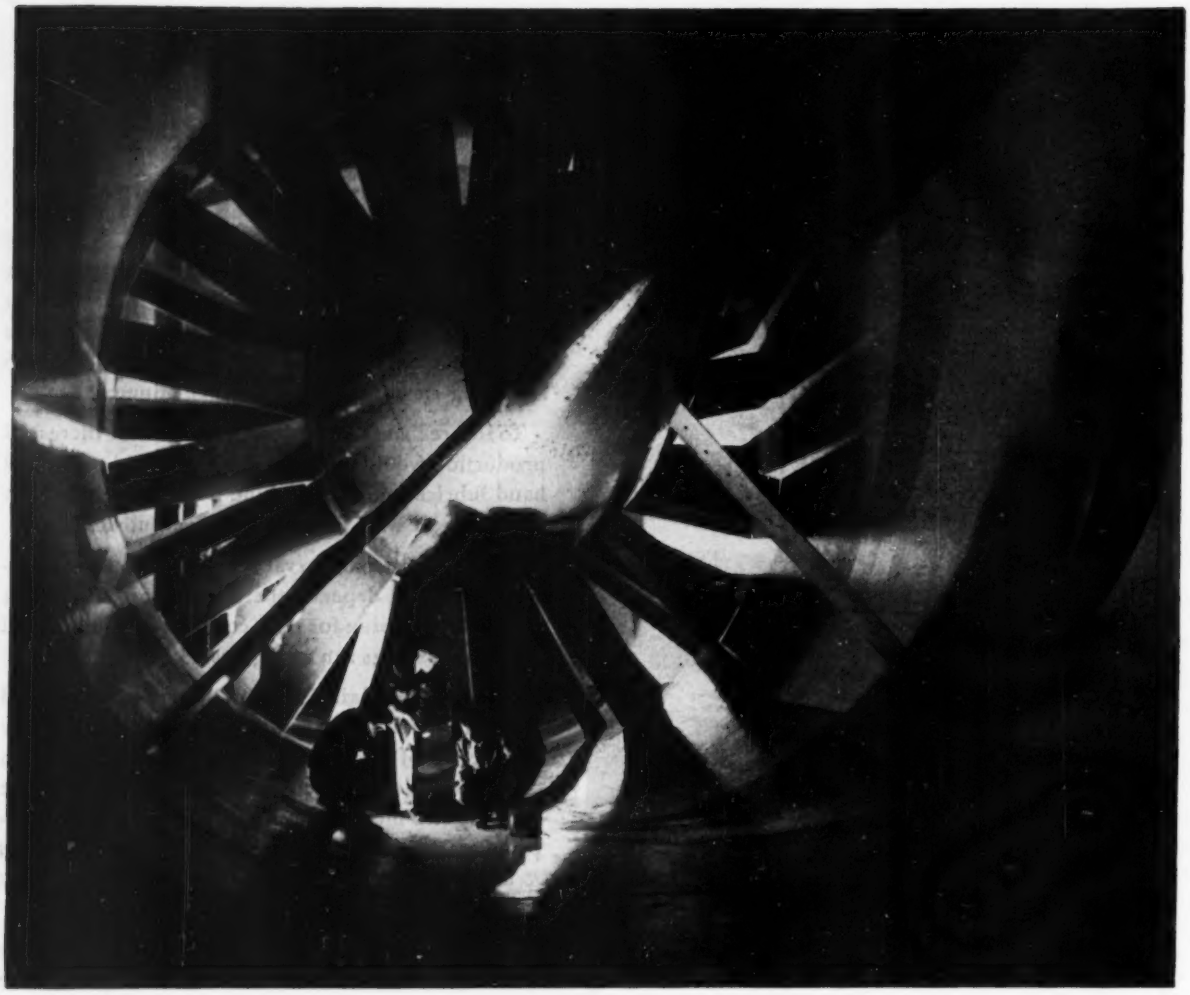
FARVAL SAVES ON BENDING ROLL LUBRICATION

	Lbs./yr. lube. 62 points	Hrs./yr. lube. 62 points	Annual Cost @ $1.50/hr. 62 points
GREASE GUN	20,592 lbs.	717 hrs.	$1,075.00
CENTRALIZED SYSTEM	5,304 lbs.	15 hrs.	$ 22.50
ANNUAL SAVINGS EFFECTED BY FARVAL	15,288 lbs.	702 hrs.	$1,051.50
COMBINED SAVING (LABOR AND LUBRICANT)			$2,579.50

AND IN ADDITION, FARVAL SAVES BEARING EXPENSE AND PRODUCTION TIME

Reports of lubrication engineers show lubrication by grease gun takes .747 minutes per point—to clean dirt from nipples, grease, move from point to point, and refill gun. With Farval it takes only 15 minutes every fourth day to refill Farval reservoir. In addition, Farval saves 3 pounds of each 4 of lubricant used by other methods.





Boeing's great new tunnel can help you

Whatever your engineering specialty, you'll get ahead faster with the backing of outstanding research facilities capable of coming up with better, more modern data. Boeing's newly redesigned 54,000-hp. wind tunnel—the only privately owned trans-sonic tunnel in the country—is an example of the research advantages that can help you get ahead in this famous company. At Boeing, too, you have at your disposal the benefits of many other research tools, such as acoustical, hydraulic, pneumatic, mechanical, electronics, vibration and physical research laboratories.

Boeing is in its 36th year of operation, and has enjoyed practically continuous growth. Today Boeing employs over 6000 engineers, in contrast to 3500 at the peak of World War II. There's room for *you* to get ahead in this growing organization—with work on such long-term projects as supersonic flight and nuclear-powered aircraft research, guided missiles, gas turbine development, America's first-announced jet transport, and the country's hottest jet bombers, the B-47 and the giant new B-52. These two bombers have given Boeing more multi-engine jet experience than *any* other company, here or abroad.

Boeing offers careers of tremendous scope to men in virtually ALL branches of engineering (mechanical, civil, electrical, aeronautical, and related fields), for **DESIGN, DEVELOPMENT, PRODUCTION, RESEARCH and TOOLING**; to servo-mechanism and electronics designers and analysts, and to physicists and mathematicians with advanced degrees.

Boeing pays you a moving and travel allowance. You can work in either Seattle or Wichita. Both of these cities provide fine fishing, hunting, golf, boating and other recreational facilities—as well as opportunities for specialized advanced training. You'll be proud to say, "I'm a *Boeing* engineer!"

Write today to the address below or use coupon.

JOHN C. SANDERS, Staff Engineer—Personnel
Dept. M-4
Boeing Airplane Company, Seattle 14, Wash.

Engineering opportunities at Boeing interest me. Please send me further information.

Name _____

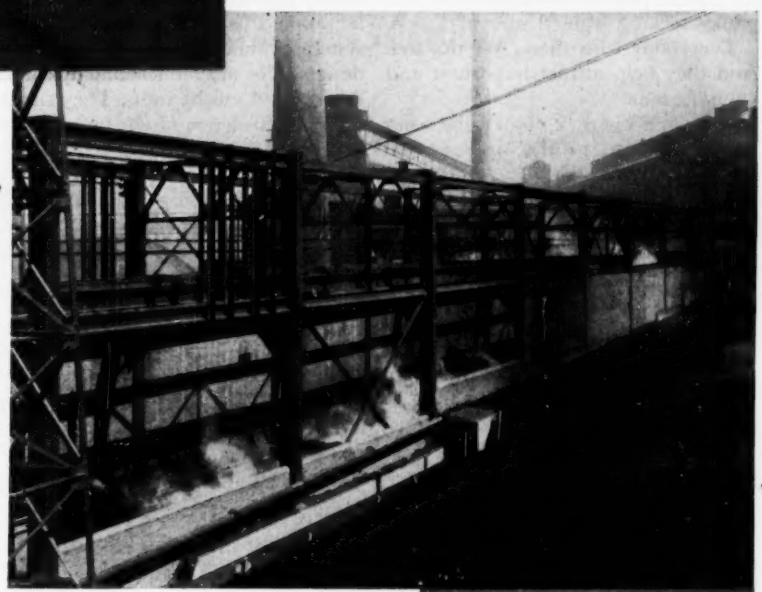
Address _____

City and State _____

BOEING

INSUL-MASTIC
The Superior Coating

. . . protects metal equipment where coke quenching fills the air with acid vapors.



This spot is considered one of the most corrosive areas in a steel mill. That's why this crane runway is coated with INSUL-MASTIC 4010. The pit under this runway receives all the steaming, acid laden water from freshly quenched coke in a mill where the water must be used over and over. All year long gnawing vapors rise from the pit and cover the steel runway. No damage results, but look at what the vapors have done to the painted steel at the far left.

INSUL-MASTIC is the *Superior* coating that protects for a great many years. Its Gilsonite content makes it practically inert to acids. Its mica content makes it almost immune to weather. It's homogenized so that nothing settles in the drum . . . it is sprayed as it is blended. It is applied 1/16″ to 1/8″ thick in one coat.

All this adds up to a *Superior* coating . . . and this crane runway is only one of the many corrosive areas in steel mills where INSUL-MASTIC guards against the attacks of corrosion.

Write for the name of your nearest INSUL-MASTIC Representative for expert advice on protecting your equipment where coke quenching and other sources of corrosion take place.

Think first of the coatings that last!

CORROSION PROOFING
WATERPROOFING
VAPOR SEALING
INSULATION

Type "D"—The cork impregnated coating that insulates as it prevents corrosion.

4010 and granules—An attractive, weather resistant resurfacing for old or leaky masonry walls.

Insul-Mastic

CORPORATION OF AMERICA
Oliver Building • Pittsburgh 22, Pa.
Representatives in Principal Cities

How Would You Solve This Problem?

YOU READ a lot of magazines. You see a lot of ads. You've seen many of the printed messages from companies seeking trained scientific men.

Everybody runs them. We do, too. And they help attract important and valuable men.

But somehow they don't quite seem to measure up to the situation we have here.

None of the usual words or phrases gives exactly the picture we'd like people to see.

We Need Engineers

You see, we have a contract with the Atomic Energy Commission. We aren't making bombs or turning out isotopes. We are building a nuclear engine for a submarine—and our next big job is to build one for a large naval vessel. Maybe that sounds more like war work and less like putting atomic energy to useful work for mankind. But—the next steps will be atomic power equipment for peacetime purposes.

Power Is Our Business

And that's our primary purpose. Because Westinghouse's business is power.

We have some great things going on in our Atomic Power Division. And we have wonderful people out here, brilliant and inspiring to work with.

The point is that we need more of them . . . of the right kind. They don't have to know anything about atoms or atomic power, but they do have to know a lot about fluid flow or heat transfer or the design and operation of central station or marine power plants or certain other phases of mechanical engineering.

. . . *Mechanical Engineers*

The mechanical engineers we need ought to have four to ten years of experience in one or more of the following fields: the design or application of structural supports for machinery . . . or high pressure piping and systems . . . or rotating machinery . . . or steam turbines, general steam apparatus and steam power systems . . . or hydraulic apparatus and systems . . . or heat exchangers and condensers . . . or hydraulic apparatus and systems . . . or systems evaluations, heat balance, valve design . . . or mechanical and hydraulic devices and mechanisms. They should have a knowledge of the properties of materials. Some of them should have experience in liaison and coordination with subcontractors and customers, scheduling and planning of ship trials and customer testing of steam plants.

Other Engineers Needed

We also need electrical engineers skilled in the design of process regulators, indicators and control devices for liquid level, flow, temperature and pressure . . . and electronic engineers with experience with electronic computers or null balance devices or plant control systems.

You'll Like Working Here

When we get people out here and talk to them, we find them ready and eager to work here. There is something fascinating about it. Maybe it's because there aren't many places in the world where the work you do seems to have much influence upon what's happening in the world. Out here, it might. Even if you only find a way to improve a heat exchanger.

We know the men we are after would like it here at Westinghouse. It's an engineer's kind of company. It's big, with thousands of employes, yet every fourth one is an engineer. Many of them have been here 20 and 25 years . . . and more than half the top executives are engineers.

There are good jobs here, at good money. And there will continue to be good jobs in this division . . . no matter what happens. Work on the atomic engines will go on. National security dictates that.

Your Wife Will Like It Here

And the wives of the men we are after will like it here, too. Sure, they'll have to live near Pittsburgh, but that's no punishment these days. This is not the Pittsburgh of old. Someone has said that Pittsburgh is now one of the most exciting cities in America. They've cleaned up the old smoke and dirt. They've torn down many of the old buildings. They're pouring billions into new residential areas, new high-speed boulevards, new parkways and other facilities for good living.

Enjoy Suburban Living

The plant is at the Bettis Field airport, 13 miles southeast of the city, in a suburban section of rolling hills. Not far away is Mt. Lebanon, one of the finest suburban living areas, where many of our people live, and Whitehall and Brentwood, bustling new communities where the downtown department stores have branches with lots of room to park. Your wife would like to know she can get all those Westinghouse appliances Betty Furness talks about at nice discounts.

For people who are just getting started, there are lots of one and two bedroom apartments within easy driving distance. For families with children, there are five colleges and universities and the fine school system that goes with that kind of higher education. For people who like cultural advantages, there is a fine symphony, an outdoor civic light opera, one of the world's great art exhibits, a top-ranking museum, a planetarium, famous Carnegie libraries.

You Get Extra Benefits

Westinghouse employes enjoy a lot of extra benefits, too—a modern pension plan; life, sickness and accident insurance and hospitalization; and the opportunity to purchase Westinghouse stock at favorable prices.

All in all, there can be great things in store for the right men if they write to C. F. Stewart, Atomic Power Division, Westinghouse Electric Corporation, Box 1468, Pittsburgh 30, Pa.

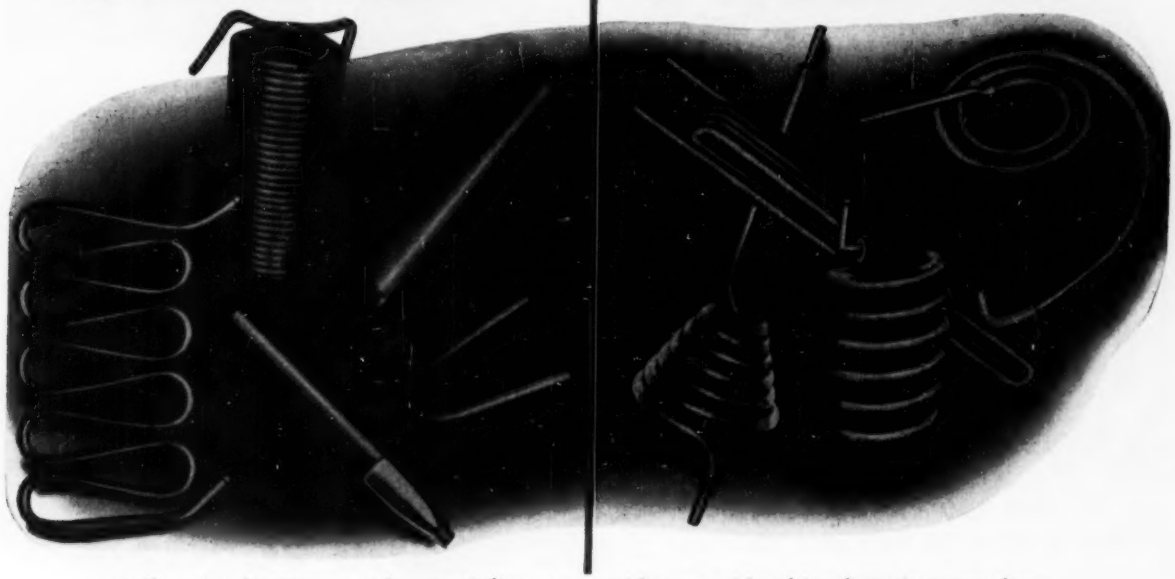
Our problem is to reach the right men. That's why we say "How would you solve this problem?"

Maybe you know someone who should be out here. *Maybe it's you.*

WOLVERINE will supply you with nonferrous tube fabricated in a variety of forms

Like this . . .
IN PLAIN TUBE

Like this . . .
IN FINNED TUBE



Call on Wolverine, as tube specialists, to provide you with tubing bent into any form that will best meet your particular requirements. Illustrated above are only a few typical forms.

Whether you require a simple bend, a closely wound coil or a more complex one — whether in plain tube or in the unique Wolverine Trufin* (the integral finned tube), it can be provided by Wolverine to your complete satisfaction.

Think of Wolverine first when you think of tube in any form — straight lengths or fabricated. Our Customer Engineering Service will be glad to help you in selecting the proper tube and tubular form. Send for our booklet, Fabricated Tubular Parts.

*REG. U. S. PAT. OFF.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

WOLVERINE TUBE DIVISION
of CALUMET & HECLA, INC.

ESTABLISHED 1916

Manufacturers of Tubing Exclusively

1437 CENTRAL AVENUE • DETROIT 9, MICHIGAN

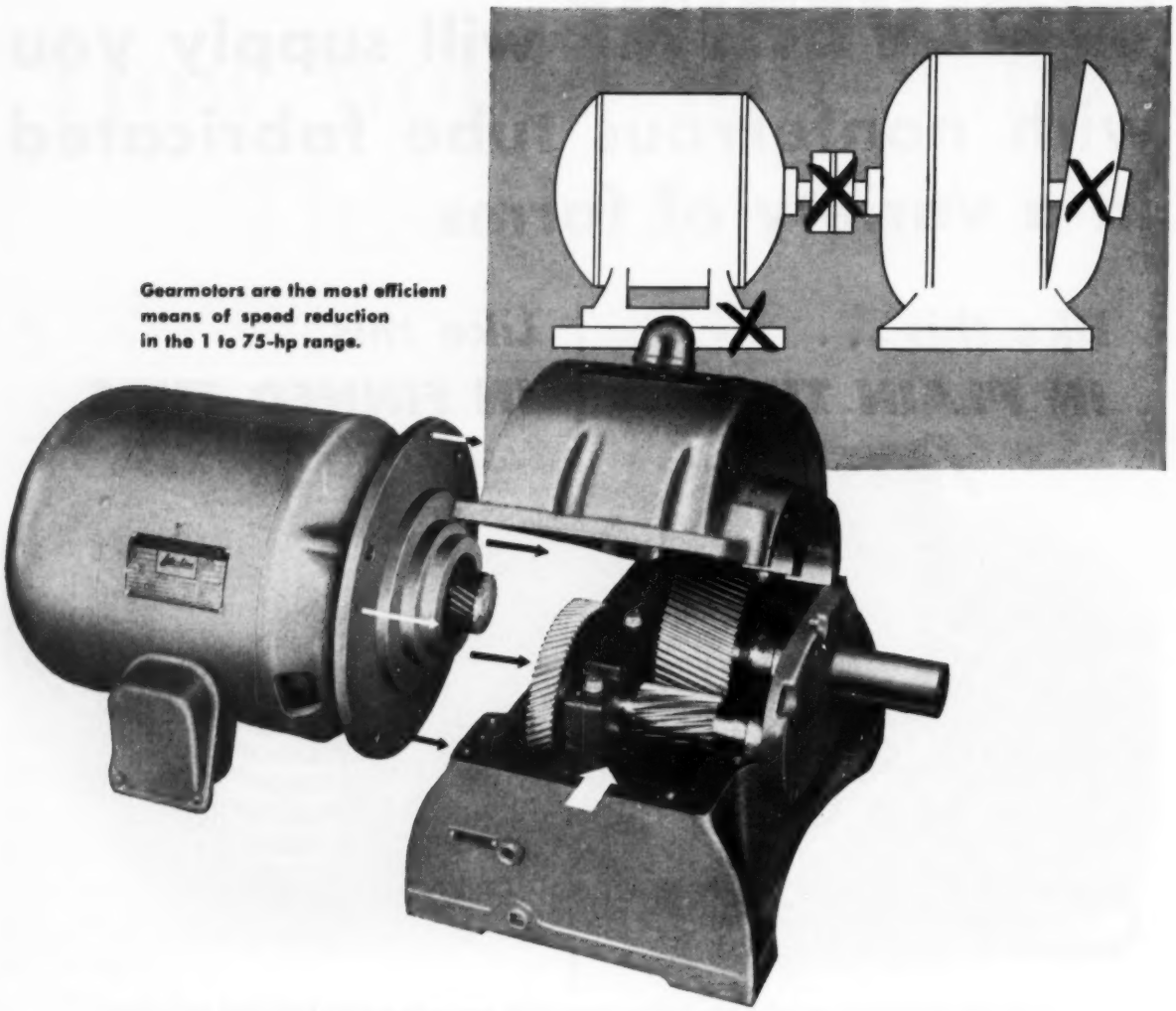
Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

Export Department, 13 E. 40th St., New York 16, N. Y.

Other Wolverine Products

CAPILATOR*
—the capillary tube for restriction purposes
COMMERCIAL TUBE
AUTOMOTIVE TUBE
CONDENSER TUBE
COPPER WATER TUBE (K-L-M)
ELECTRIC WELDED STEEL TUBE
FABRICATED TUBULAR PARTS
WOLVERINE TRUFIN*
—the integral finned tube
REFRIGERATION AND AIR CONDITIONING TUBE (Plain or Tin Plated)
S.P.S. PIPE
SPUN-END TUBE†

*Reg. U.S. Pat. Off.
† A Patented Process RE 22465



Gearmotors are the most efficient means of speed reduction in the 1 to 75-hp range.

Here's why Life-Line GEARMOTORS stay on the job longer

LESS TIME OUT FOR SERVICING MOTOR

Removing the motor from a Life-Line gearmotor takes but a few minutes. Remove the motor mounting bolts and you are on your way—and, reassembly is just as simple and fast. Install the mounting bolts and the job's complete. No realigning of shafts—no coupling to adjust—no mounting feet to shim.

Should you be "on the spot" where down time is critical, this means that your spare motor can be quickly and easily installed. At the most, it is a simple assembly of the adapter bracket.

LESS TIME OUT FOR SERVICING GEARS

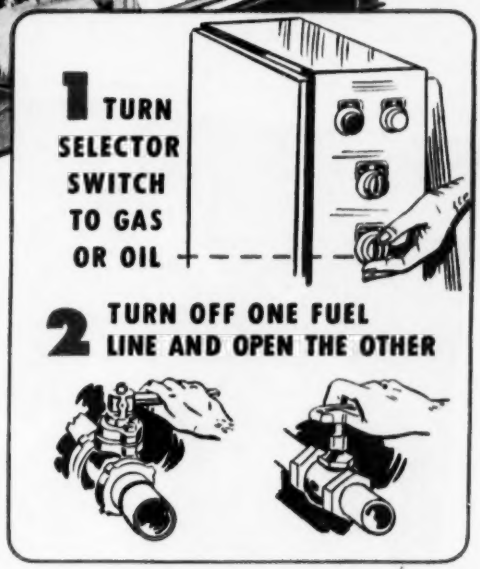
Here again, Life-Line's split case construction pays off. Simply by removing the top half of the gear case, the gears can be inspected or removed without touching the mounting bolts—without draining the oil—without disturbing the connected load.

Ask your Westinghouse representative for the details on how Life-Line gearmotors pay for themselves in production time saved. For descriptive literature, write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-07313-A

YOU CAN BE SURE...IF IT'S Westinghouse

NOW... interchange Gas and Oil firing in *10 seconds*

Modern Cleaver-Brooks Model LR Steam Boiler Equipped with Exclusive Cleaver-Brooks "10-second conversion" Combination GAS and/or OIL Burner



TWO, simple motions eliminate time-consuming change-over

Now you can use oil or gas at the flick of a switch! This exclusive new Cleaver-Brooks development permits changeover from oil to gas or vice versa in only 10 seconds.

That's because the Cleaver-Brooks Combination Gas and/or Oil Fired Boiler operates on gas *with the oil burner in place*. Simply flipping a selector switch on the control panel to either gas *or* oil sets the proper circuit in action. Turning the convenient fuel supply valves completes the entire changeover — and in 10 seconds or less!

To gas users in all parts of the country — and in particular areas where local requirements demand immediate changeover — this exceptional fuel flexibility can be an important factor in determining your overall operating economy.

Ten-second conversion, like 4-pass construction, self-contained design, guaranteed 80% efficiency, is another "plus" feature pioneered by Cleaver-Brooks. It demonstrates Cleaver-Brooks' continuing effort to bring steam users even greater flexibility and reduced operating costs.

If you are considering simplifying your present boiler plant, remember Cleaver-Brooks Combination GAS and/or OIL Fired Boilers. Sizes 15 to 500 h.p. — 15 to 250 p.s.i. Write for complete facts.

Cleaver-Brooks

Originators of the Self-Contained Steam Boiler

CLEAVER-BROOKS COMPANY

Dept. D-319 E. Keefe Ave., Milwaukee 12, Wis., U.S.A.

Cable Address: Clebro-Milwaukeewis

Builders of Equipment for the Generation and Utilization of Heat • Steam Boilers • Oil and Bitumen Tank-Car Heaters • Distillation Equipment • Oil and Gas-Fired Conversion Burners

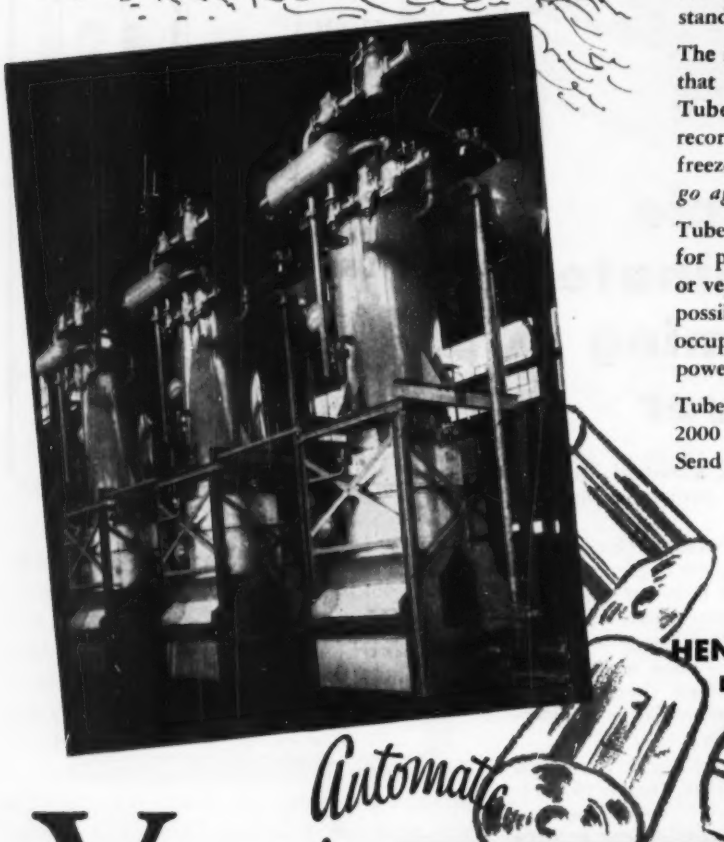
186,072,500 pounds of Tube-Ice used in building 2 WESTERN DAMS*

Yes—that much ice was required to cool the concrete mix in order that it set properly to develop its ultimate strength for two outstanding dam structures.

The important part of this message to you is that the compact and readily portable Vogt Tube-Ice Machines pictured here set this record without even the replacement of a freezer tube. What's more, they are *ready to go again* whenever ice is needed in quantity.

Tube-Ice is widely used in process work and for preserving shipments of meat, fish, milk or vegetables . . . and is produced at the lowest possible cost per ton since a Tube-Ice unit occupies less space, has fewer parts, uses less power than any other method for making ice.

Tube-Ice Machines are available in sizes from 2000 lbs. per day up to any desired capacity. Send for free Bulletin TI-3.



**McNary Dam, Washington, and Pine Flats Dam, California, required a total of 2,730,000 cu. yds. of ice cooled concrete mix.*

HENRY VOGT MACHINE CO.
LOUISVILLE 10, KENTUCKY
BRANCH OFFICES
Philadelphia, Chicago, Cleveland,
St. Louis, Dallas, Charleston, W. Va.

Automatic

Vogt TUBE-ICE MACHINE

WHAT ARE YOU LOOKING FOR IN GEARS?

You get *all* of these in Farrel-Sykes gears — because they are *all* the product of precision generation, plus high-grade materials, plus the herringbone design.

Farrel-Sykes gears are made of the finest-grade materials available. They are generated by the famous Farrel-Sykes method — a process that assures extreme accuracy of tooth spacing, contour and helix angle.

The herringbone design provides evenly distributed pressure over each tooth, from tip to working depth line. This means that there is no tendency for the contour of the teeth to wear unevenly and thus shorten the life of the gears.

Wherever power transmission must be smooth, quiet, and vibrationless under all conditions of load and speed, *specify Farrel-Sykes herringbone gears.* Information and engineering assistance available, without obligation.

Farrel-Sykes herringbone gears are made in any size from ¼" to 20' 0" diameter, for any power capacity and speed. Also available are straight tooth and single helical gears in sizes up to 20 feet diameter, and large internal gears with either spur or helical teeth.

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.—*Plants:* Ansonia & Derby, Conn., Buffalo, N.Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Detroit, Chicago, Memphis, Minneapolis, Portland (Oregon), Los Angeles, Salt Lake City, Tulsa, Houston, New Orleans

Farrel-Birmingham®

FB-810

New simplicity in process cooling!

Yours now from a single packaged unit—the new TRANE Cold-Generator

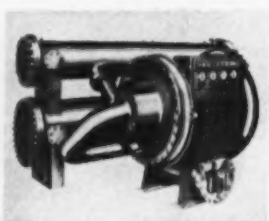
New TRANE Cold-Generator . . .

factory assembled, tested . . . ready to install!

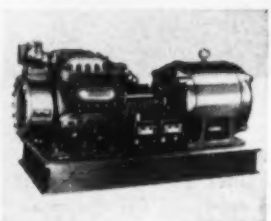
Now you can have chilled water *from a single package* at a temperature exactly suited to electroplating, metal quenching, die cooling, rubber mixing . . . almost any industrial process.

The new TRANE Cold-Generator combines the TRANE Reciprocating Compressor with matched components into a single compact unit . . . factory engineered, factory assembled, factory tested. Factory guaranteed! *So simple to install that your regular crew can do the job quickly, easily. No refrigeration work required—it's done for you at the factory!*

Five sizes for loads from 10 tons up. Only simple electrical and plumbing connections needed.



For larger jobs, choose CenTra-Vac—this hermetic centrifugal refrigeration unit provides 45 to 200 tons of refrigeration. Self-contained, completely automatic. Only one major moving part.



TRANE Reciprocating Compressor assures long life, quiet operation, simplified installation and maintenance on any process or comfort air conditioning system. Capacities from 3 to 50 tons.

New TRANE Cold-Generator

brings you process cooling in a package!

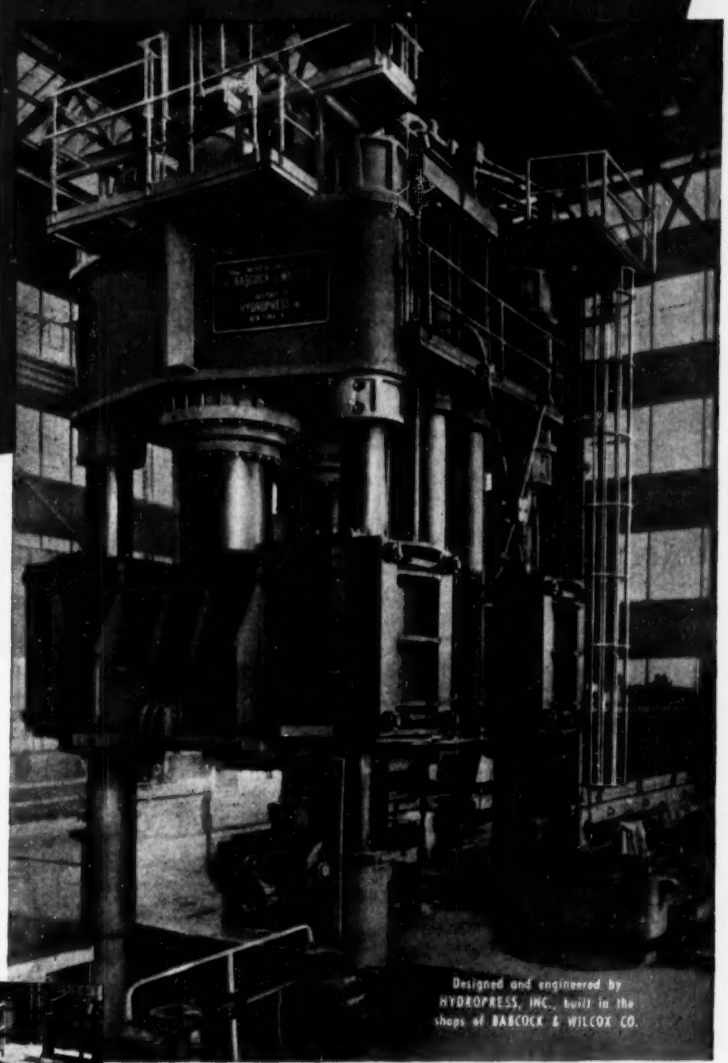
The Trane Company, La Crosse, Wis. • East. Mfg. Div., Scranton, Penn. • Trane Co. of Canada, Ltd., Toronto • 87 U.S. and 14 Canadian Offices

MANUFACTURING ENGINEERS OF HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT

"the nation's largest press

and the introduction into America of a method of forming heavy-wall hollow forgings by piercing and drawing an ingot . . ."

-- says BABCOCK & WILCOX for whom HYDROPRESS, INC. designed and engineered it



a Multi-Purpose Press for

- Forming the heaviest Steel Plate ever rolled up to max. 42 feet length and 6" wall thickness into Boiler Drum Sections.
- Piercing heated Steel Ingots for subsequent drawing of Seamless Steel Tubes and Hollow Vessels for high-pressure steam lines.
- Easily convertible to the forming of heavy pressure vessel heads, warped sections and general purpose presswork such as upsetting, reducing, expanding, cold drawing, etc.

▲ 6,500 Ton Hydraulic Piercing and Bending Press — intensified capacity 8,500 Ton — at the Boiler Division, BABCOCK & WILCOX, Barberton, Ohio.

▲ HYDROPRESS, INC., also designed and engineered the Hydraulic Push Bench — largest in America for this purpose — on which BABCOCK & WILCOX draws the ingots or billets of varying cross sections — pierced on the press shown above — into seamless Steel Tube and High Pressure Vessels from a minimum of 8" I.D. up to max. 26" I. D., 4½" Wall Thickness and 22 feet length.

LOEWY

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ENGINEERS • CONTRACTORS

Rolling Mills • Hydraulic Presses • Pipe Testing Machines • Special Pipe Mill Equipment • Accumulators • Pumps • Die Casting Machines

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BIRMINGHAM • CHICAGO • CLEVELAND • DETROIT • LOS ANGELES • PHOENIX • SAN FRANCISCO • SEATTLE • WASHINGTON, D. C. • WHEELING

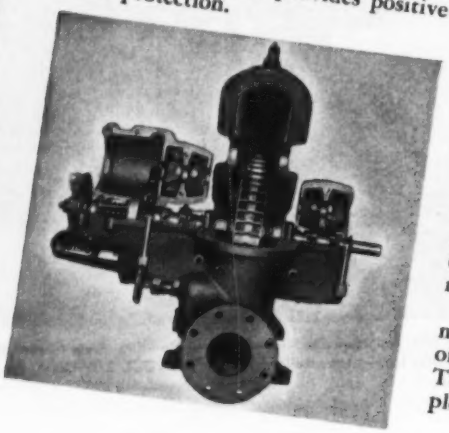
GENOA, ITALY • LONDON, ENGLAND • MADRID, SPAIN • PARIS, FRANCE • PHILIPPINE ISLANDS

TERRY

PROTECTION OF TURBINE BLADES made possible by nozzle location

The Terry Solid-wheel Turbine is of the impulse, helical flow type. The steam issues from an expanding nozzle at high velocity and enters the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is returned to the wheel several times until practically all of the energy has been utilized. This principle makes possible the efficient use of steam in a single-piece, almost indestructible wheel.

In the Terry Solid-wheel Turbine, the steam enters the buckets in a direction at right angles to the shaft, as shown above. This design eliminates the need for close clearances and provides positive blade protection.



The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, projecting rims on each side of the buckets prevent damage to the blades even though external thrust should move the wheel.

This is only one of the many important features of the Terry Solid-wheel Turbine. Write for complete details.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1195

Memo

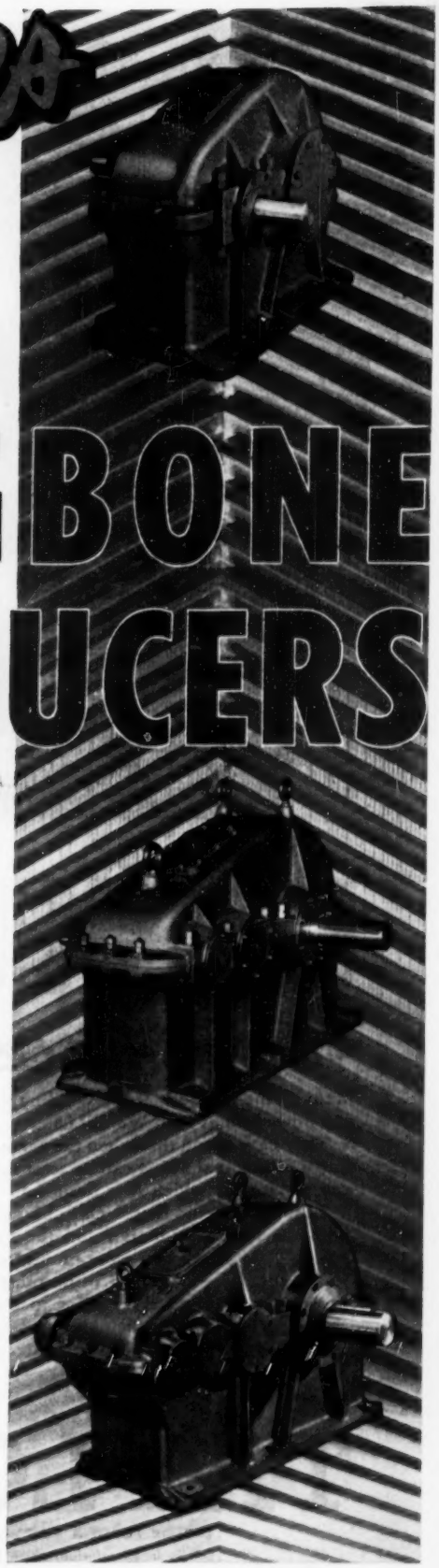
Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

D.O.James

Established 1888

CONTINUOUS-TOOTH HERRINGBONE GEAR REDUCERS

The Gear with the Backbone



Some of the Many Proven *On-the-Job* Advantages of This Type of Gear Reduction Are as Follows

1. No side thrusts.
2. No avoidable deflections, distortions.
3. No necessity for bearings having thrust capacity.
4. Stronger teeth, due to the arch-like construction.
5. Greater load-carrying capacity due to utilization of the full width of face.
6. More silent and smoother action due to absence of distortion.
7. No impact stresses due to avoidance of sideways deflections.
8. Uniform load across face due to balanced thrusts of the opposing helices.
9. Better lubrication due to the oil film formed by "wedge action" of the teeth.
10. Less costly to produce due to the absence of side thrusts and no necessity for heavy sections to reduce deflections — also due to the simultaneous utilization of two cutting tools.
11. Can be substituted for straight tooth gears without any change in design of bearings or housings, or increase in face width, or alteration in pitch.
12. No axial float is necessary because the "V" shaped herringbone teeth wedge automatically into the mating gear thus eliminating all sideways motion and the consequent rubbing action of a screw-like nature existing in single helical gears which result in pitting and wear at relatively low loads.
13. Less expensive gear housings and bearing housings due to balanced thrusts.
14. Large helical angles are used; thus the full benefit of the helical principle is obtained.
15. Tooth deflection, though very small, results in the greatest load being carried by the strongest section.

All Gears are Generated Continuous-tooth Herringbone Gears, 20° pressure angle, 30° helix angle

Send for Catalog 40-C

D.O.JAMES GEAR MANUFACTURING CO.

Since 1888 • Makers of Every Type of Gear and Gear Reducers

1140 W. MONROE STREET • CHICAGO 7, ILLINOIS

WeldELLS®

...have set their own standards

Many of the largest users of Welding fittings refuse to accept any other fittings than WeldELLS.

They have found that when the name, WeldELL, is stamped into a fitting, that fitting can be accepted without question for any service for which it is designed.

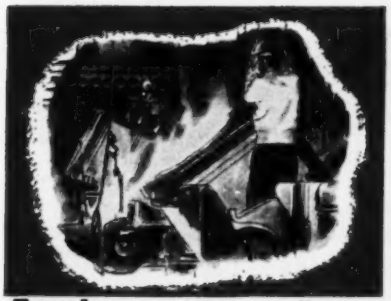
They have found that WeldELLS have features that please both the men who design and the men who erect welded piping . . . features that were pioneered by Taylor Forge . . . features that are combined in no other welding fittings.

They have found the answer to their every need in the greater range of sizes, weights and types of the WeldELL line . . . in the broader scope of materials.

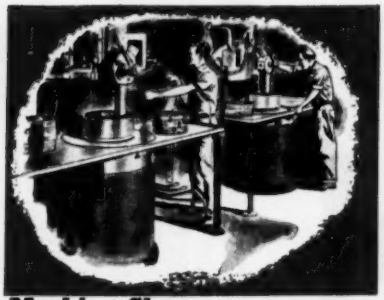
TAYLOR FORGE

TAYLOR FORGE & PIPE WORKS, General Offices and Works: P.O. Box 485, Chicago 90, Ill.

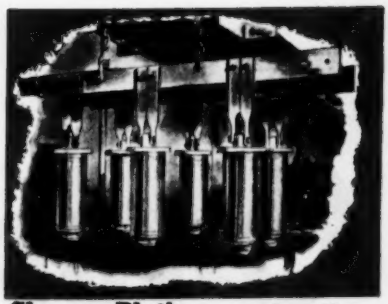
Offices in all principal cities. Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont., Canada



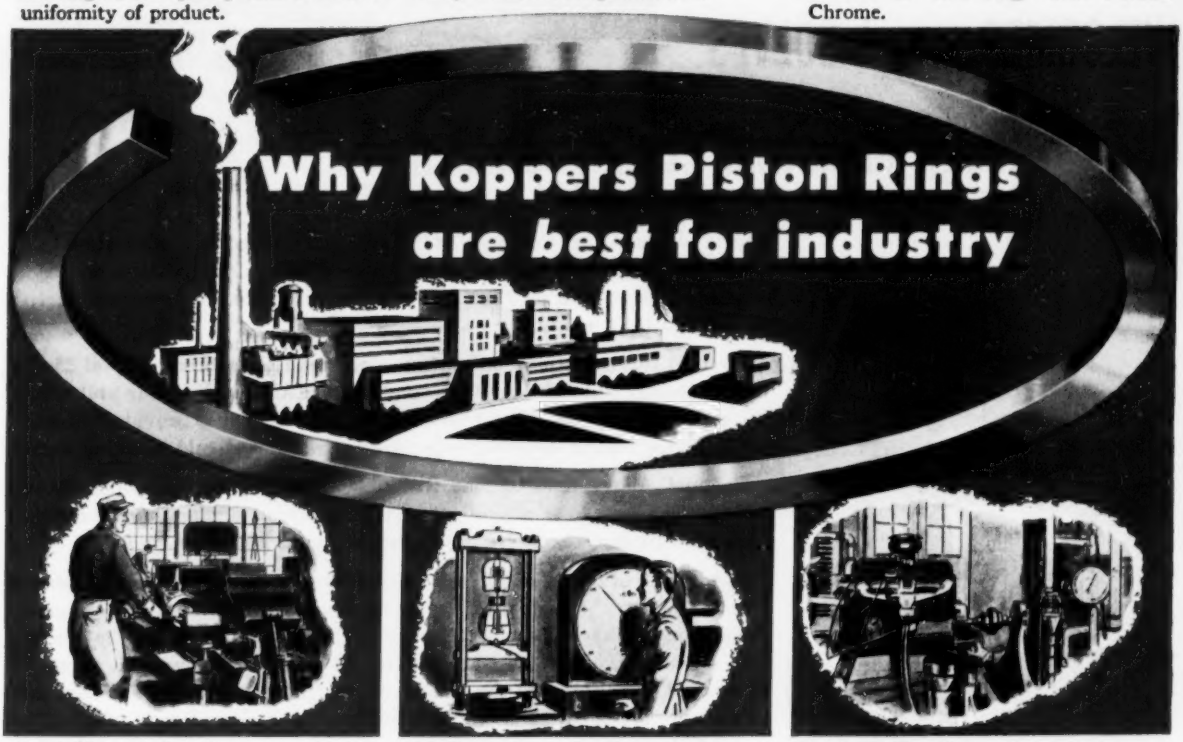
Foundry . . . where top-quality raw materials first assume the shape of piston rings. Strict quality control assures uniformity of product.



Machine Shop . . . where every conceivable size and type of ring is precisely machined to specification.



Chrome Plating . . . where Koppers uses the famous Van der Horst Process to coat rings with Porous Chrome.



Centrifugal Casting . . . an exclusive Koppers process that increases the strength of rings up to 4 times that of ordinary rings.

Engineering & Research . . . where constant testing, checking and experimenting result in better and better piston rings.

Engine Testing . . . where Koppers Rings are tested under far more severe conditions than they will ever be subjected to in ordinary use.

KOPPERS manufactures piston rings in every size, of every type, for every conceivable purpose. Koppers has the solution to every ring problem, whether in gasoline or diesel engines, compressors, hydraulic presses, steam locomotives or any other industrial or aircraft applications.

Koppers engineering, research and manufacturing facilities are responsible for recent important piston ring developments, K-Iron® and Porous Chrome*. K-Iron is a high-grade, closely-controlled material that imparts superior wear properties to piston rings and is surface treated chemically as an anti-scuffing aid.

Koppers Porous Chrome Rings hold and distribute oil during the break-in, quickly wear to best possible seating, *cut cylinder wear up to 50%, last up to 4 times as long as ordinary rings!*

*Van der Horst Process

Write, wire or phone us for experienced help with your problems. Koppers Company, Inc., Piston Ring Dept., 1534 Hamburg St., Baltimore 3, Md.

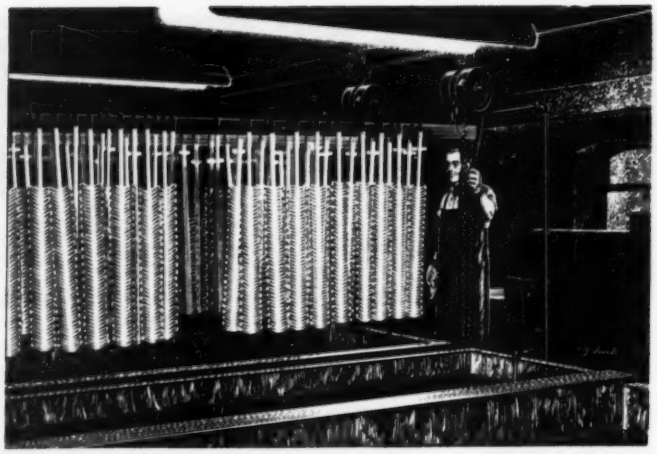
KOPPERS®

Koppers American Hammered Industrial Piston Rings

Only KOPPERS *can furnish K-Spun® and Porous Chrome!*

Servel

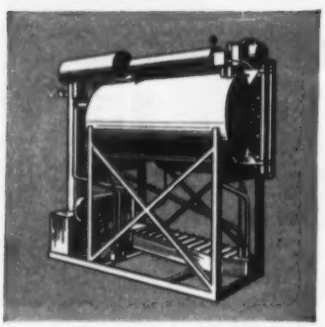
WELCOMES...and SOLVES



tough industrial cooling problems

When Colonial Alloys Company of Philadelphia decided to anodize aluminum products by the new and different Electrodizing Conservation or "EC" process, it faced the problem of maintaining proper temperature of the electrolytic bath solution.

To meet this essential requirement, Colonial Alloys chose a Servel 25-ton Water Chiller. Not only does this single Servel Air Conditioning unit maintain constant, controlled solution temperature, but it also provides office air conditioning, chilled water for experimental work, and cold drinking water.



The 25-ton Water Chiller used in the Servel installation at Colonial Alloys Company.

Colonial Alloys reports that the new "EC" process, in which Servel equipment plays such a leading part, has *increased aluminum anodizing production as much as five times, while cutting costs as much as 99%!*

This is one of many examples of how Servel Air Conditioning equipment benefits industry. Chances are, your problem can be solved in an equally satisfactory manner. Because Servel Air Conditioning *uses heat to produce cold*, operating economy is outstanding. It operates on gas, oil, steam or waste heat—whichever is the most economical fuel in your area. There are *no moving parts* to wear or cause vibration. And every Servel unit carries a complete *five-year warranty*.

★ ★ ★

Servel manufactures the world's finest air conditioning equipment to fit all air conditioning needs—residential, industrial, commercial—all-year or cooling alone. For complete information, clip and mail the coupon today.

Servel

the name to watch for great advances in—

AIR CONDITIONING ✓ REFRIGERATION

SERVEL, INC., DEPT. ME-4, Evansville 20, Indiana

I want to know more about industrial uses of Servel Air Conditioning.

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Title_____

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The All-Electric Adjustable-Speed Drive

designed to supersede mechanical gear boxes, clutches and variable-pitch cone pulleys

RELIANCE V★S DRIVE®

JR.

3/4 to 3 HP.

STYLE E

Get the Facts!

Ask for Bulletin D-2102. It describes and illustrates features, applications, components and operation; dimensions and characteristics are also included.

SAVES YOU MONEY 10 WAYS!

- Boosts output
- Cuts down rejects
- Saves space
- Increases safety
- Handles more jobs
- Reduces "down time"
- Simplifies machine design
- Reduces operator fatigue
- Cuts changeover time
- Operates from a-c.

D-1461

RELIANCE ELECTRIC AND ENGINEERING CO.

1062 Ivanhoe Road, Cleveland 10, Ohio • *Sales Representatives in Principal Cities*

These huge natural gas engines, about 40 to a room, drive the generators, furnishing all the electricity used by Alcoa to produce 170,000,000 pounds of aluminum in this plant yearly.

800 BOXCARS OF AIR

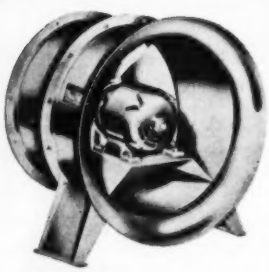
KEEP GENERATORS AT PEAK EFFICIENCY

Down at Point Comfort, Texas, a new kind of power plant was built a few years ago. 120 engines, running on natural gas, drive huge electric generators. Their job: to supply the current to smelt defense-needed aluminum. One of the biggest problems, though, was to keep the equipment running cool and thus at top efficiency.

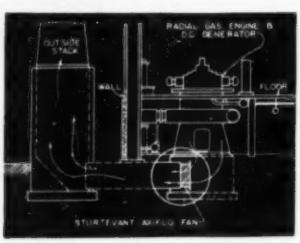
120 Westinghouse Axiflo® fans did the trick. Each draws 12,000 cubic feet of air through the generators every minute, picking up the excess heat. Then the air is piped through concrete ducts and out exhaust stacks which line both sides of the building.

Now Alcoa has just expanded this power plant. They have installed 74 new engines—and Westinghouse has supplied 74 more Axiflos. All in all, the 194 fans will move over 2,300,000 cubic feet of cooling air through the generators *every minute*. That's enough air to fill a trainload of 800 boxcars!

One day—today or in the near future—you may have a problem that involves *putting air to work*. When you do, remember that Westinghouse has the most complete air conditioning, air cleaning and air handling line in the industry. See the new Catalog 600. It contains 60 fact-filled pages on products, uses, and helpful data. To get your free copy, just call your local Westinghouse-Sturtevant office. Or, write to Westinghouse Electric Corporation, Sturtevant Division, Hyde Park, Boston 36, Mass.



Axiflo Fans keep them cool. They're compact, efficient, and trouble-free. That's important for hard-to-get-at jobs.



Cooling-air drawn through the engine generators picks up the intense heat, then safely exhausts it through individual stacks.

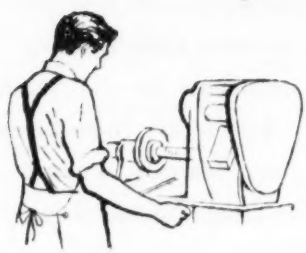
YOU CAN BE SURE... IF IT'S Westinghouse

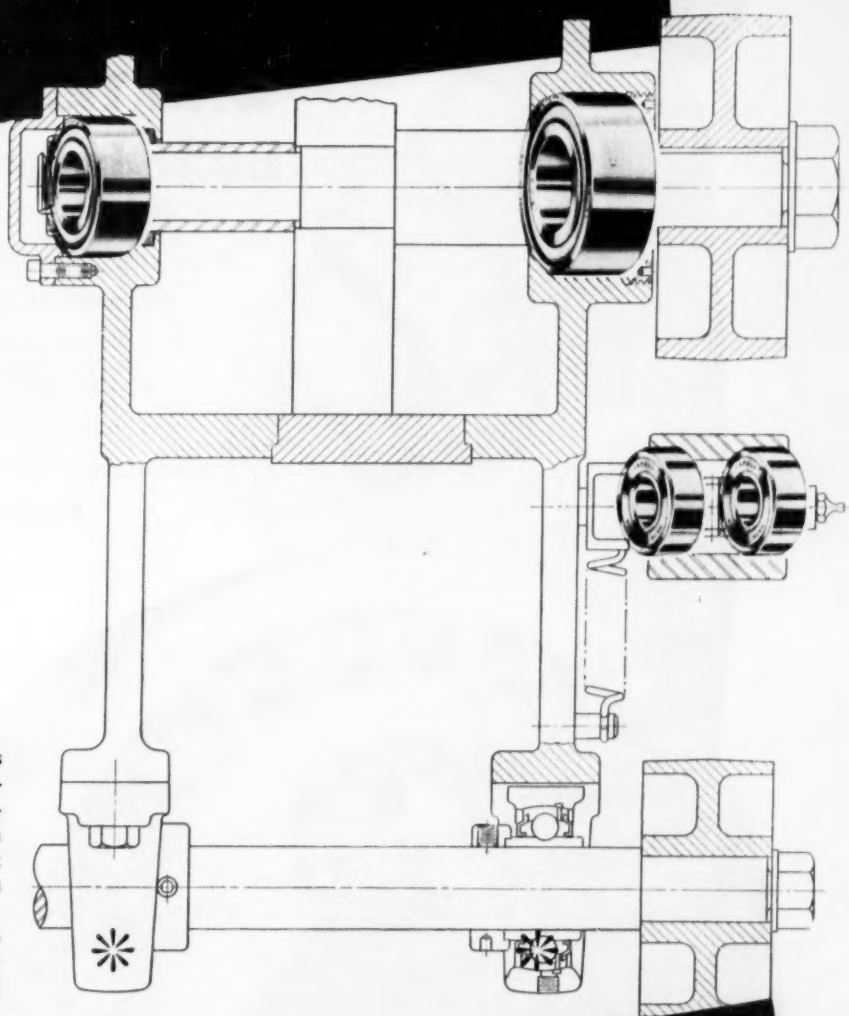
J50251

AIR HANDLING

GOING STEADY...for 16 years

Arbor Spindle Assembly on Polishing Machine

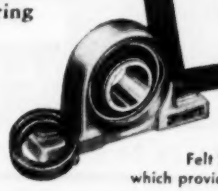




In 1937, this arbor spindle was constructed and put into operation. It has been running constantly since then . . . through World War II and the present Defense Era. By means of various pulley and belt combinations, it has a speed range from 585 to 10,000 r.p.m. on the arbor spindle pulley. The assembly is equipped with grease-lubricated ball bearings . . . none have been replaced.

Maintenance problems were practically eliminated by the careful selection and arrangement of the right bearings on this installation . . . and the assembly's service life was extended materially. Here is a typical example of the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the user's viewpoint, an aptitude for coming up with the precise bearing to fit the need. Maybe this combination can help you find a better, cheaper way to use bearings. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA



***Fafnir Standard Duty Pillow Blocks** incorporating Fafnir Wide Inner Ring Bearings with Mechani-Seals are used in addition to Fafnir Felt Seal type Ball Bearings and Fafnir Double Row Bearings which provide increased axial and radial rigidity in limited space.

tiny to
giant-sized bearings

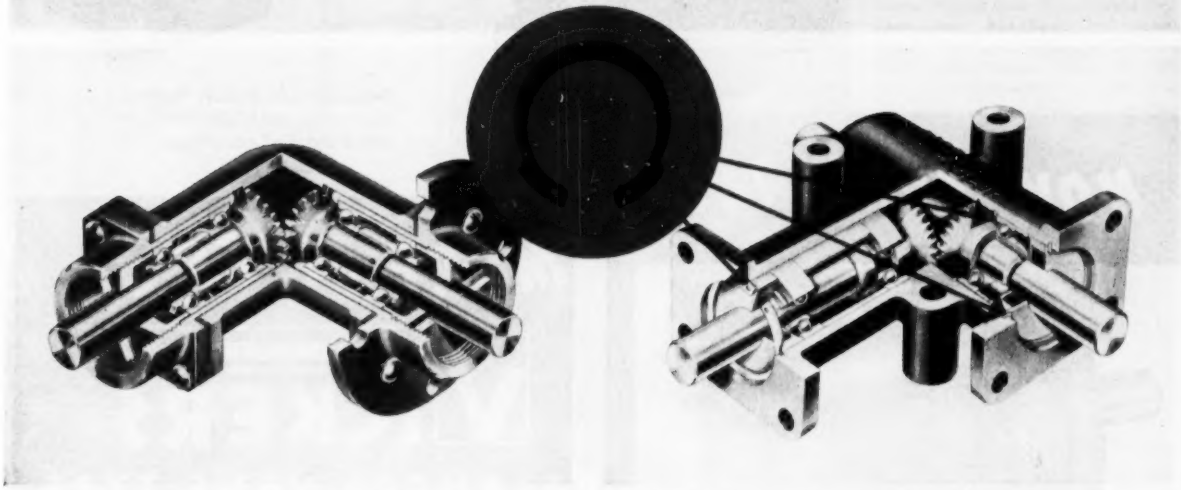
with TEAM-WORK built-in every size

With every size in SKF's wide range of ball and roller bearings, you receive an extra quality—*team-work*. This is the ability of SKF field and home office engineers to cooperate productively with your equipment designers. Helping to solve their bearing problems is the *extra* which all industries have learned to expect from SKF.

SKF
BALL AND ROLLER BEARINGS

SKF INDUSTRIES, INC., PHILA. 32, PA. — *manufacturers of* **SKF** *and* HESS-BRIGHT *bearings.*

3 Waldes Truarc Rings Replace 19 Parts ...Save $6.75 Per Unit...Cut Weight by Nearly 16%



OLD WAY 2 Threaded nuts locked bearings in place. 8 screws and washers positioned bearing and shaft assemblies. This fastening method required expensive tapping and threading. Assembly was slow and costly.

TRUARC WAY Two Truarc inverted rings (Series 5008) provide uniform shoulder to lock bearings in place, position bearing and shaft assemblies. Additional Truarc Ring (Series 5100) locates ball bearing ...eliminates 1 sleeve type spacer.

Airborne Accessories Corporation, Hillside, New Jersey, uses Waldes Truarc Retaining Rings to take *all* thrust load from right angle bevel gears in their ANGLgear*. Truarc Rings make ANGLgear* more compact—save approximately ¼" at each end of housing. By providing a choice of 3 mounting possibilities — instead of 1 — Truarc Rings make ANGLgear* adaptable to many different assemblies. New design increases load capacity . . . eliminates machining of threads.

Redesign with Truarc Rings and you, too, will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Waldes Truarc Rings are precision-engineered . . . quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

*Trade Mark of Airborne Accessories Corp.

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TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,848; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,308; 2,509,081 AND OTHER PATENTS PENDING

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog. ME 045

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Name .....

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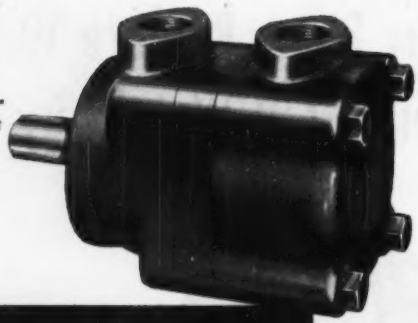
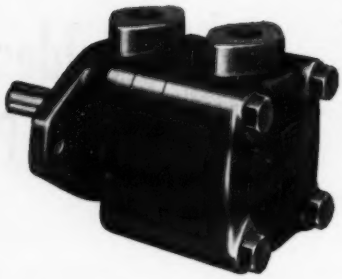


Series M2-300 Vickers Hydraulic Motors made in three sizes with 3 styles of mountings.



Series M2-200 Vickers Hydraulic Motors made in two sizes with 2 styles of mountings.

NOW AVAILABLE—

Series M2-400 Vickers Hydraulic Motors made in two sizes with 3 styles of mountings.

MORE SIZES of VICKERS BALANCED VANE TYPE HYDRAULIC MOTORS

Series M2-500 Vickers Hydraulic Motors made in two sizes with 2 styles of mountings.

Now in production are two more series of Vickers Balanced Vane Type Hydraulic Motors. They are now available in nine sizes and have normal horsepower ratings to 28.5 hp. Among the important features of these simple and rugged hydraulic motors are: (1) more horsepower for less money, (2) hydraulic balance for longer life and less maintenance, (3) automatic wear compensation, (4) dynamic balance and quiet operation, (5) exclusive "rocking beam" construction. Get in touch with your nearest Vickers Application Engineering office for further information; ask for new Bulletin M-5103.

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Write for NEW Bulletin M-5103

6219

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

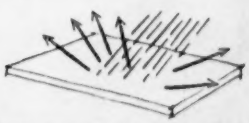
the practical answer to your rust problems indoors and out . . . . . so easy to use that one man often does the work of two.

FACTS

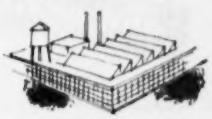
prove the economy of Rust-Oleum

Apply Directly Over Sound Rusted Surfaces—Brush Rust-Oleum 769 Damp-Proof Red Primer *directly* over *sound rusted surface* after scraping and wire-brushing to remove rust scale and loose rust. Sand-blasting, chemical pre-cleaning and other costly preparation methods are *not* usually required.

Available In Many Colors, Aluminum, and White, Brush, Dip, or Spray—Get *double protection.* Beautify as you protect with Rust-Oleum finish coats in the color of your choice.



Practical, Economical Answer To Your Rust Problem—Rust-Oleum resists rain, heat, fumes, sun, salt air, salt spray, and many chemicals—as well as condensation indoors.



Proved Throughout Industry For Over 25 Years—On tanks, girders, pipes, machinery, roofs, buildings, fences, stacks, throughout industry — Rust-Oleum has *proved* its capacity to stop rust for over *25 years.*

RUST-OLEUM®

STOPS RUST!

Resists Rain, Snow, Heat, Fumes, Weathering, Salt Water, etc.

Rust-Oleum *cuts costly manhours!* Just scrape and wirebrush to remove rust scale and loose rust . . . then brush Rust-Oleum 769 Damp-Proof Red Primer *directly over the sound rusted surface.* Rust-Oleum finish coatings available in many colors, aluminum, and white give you *double protection.* Sandblasting and other costly preparations are *not* usually required. Specify Rust-Oleum . . . prompt delivery from Industrial Distributor stocks in principal cities.

RUST-OLEUM CORPORATION
2903 Oakton Street, Evanston, Illinois

FREE SURVEY: Ask a Rust-Oleum specialist to conduct a survey including actual applications, tests, and recommendations. No cost or obligation.
See Sweets for nearest Rust-Oleum distributor or write for literature today.

There is Only One Rust-Oleum

Distinctive as your fingerprint, Rust-Oleum is an *exclusive formula* developed by a Master Mariner during more than 20 years battling actual rust conditions at sea. It incorporates a *specially-processed* fish oil vehicle that will *dry,* is *odor-free,* and is formulated in *many colors.* Be sure you specify genuine Rust-Oleum to assure satisfaction. Accept no substitute.

ATTACH TO YOUR LETTERHEAD—MAIL TODAY!

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- ☐ Have a Qualified Representative Call
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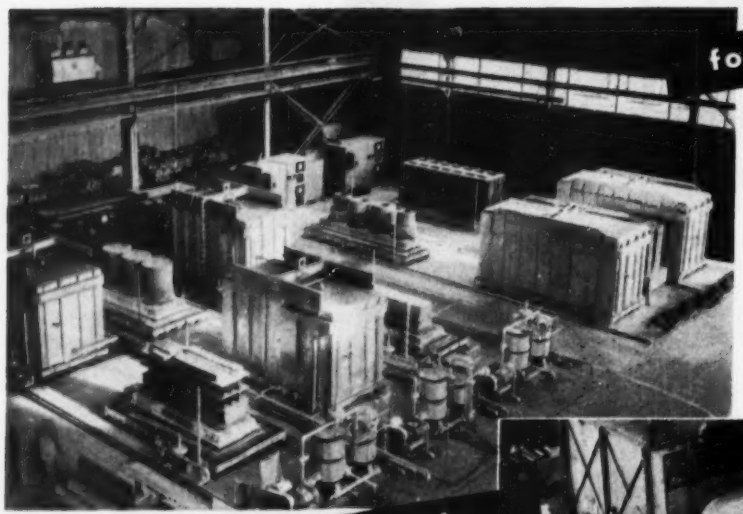
DRYing is a production tool at Pennsylvania Transformer

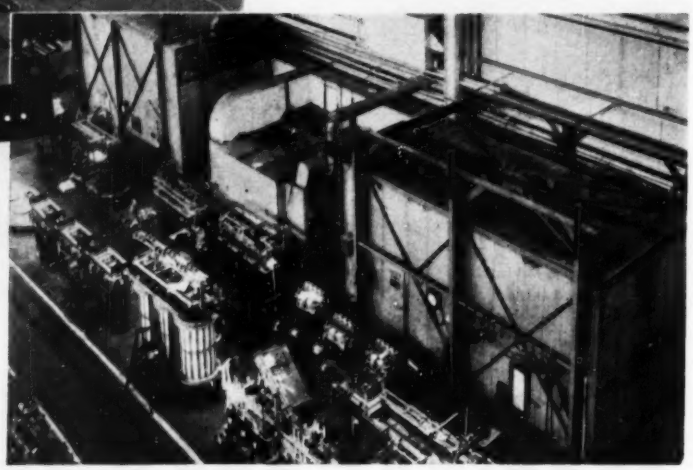


for a better start...

All core steels are annealed uniformly in these DRY controlled atmosphere furnaces.

Three Lectrodryers* are placed in a production line manner right alongside the furnaces they serve at Pennsylvania Transformer Company, Canonsburg, Pa. They DRY controlled atmospheres as these gases are fed into the furnaces, thereby preventing attack on the core steels being annealed.

and at final assembly...



Humid weather, once tough on production schedules, has been tamed by this Lectrodryer.

Again in final assembly, a Lectrodryer is helping to maintain top quality, while also speeding output. It dries the air supplied to these coil drying ovens, making production independent of outside weather conditions A typical timesaving was a 92-hour drying period reduced to 32 hours.

Whether your DRYing problem concerns air, gases or organic liquids entering into processes, or air surrounding materials in storage or manufacturing areas, Lectrodryers can remove that moisture. Tell us your troubles and we'll suggest a cure, drawing on our many years of experience in solving similar problems.

The book, "Because Moisture Isn't Pink", shows you how others have made Lectrodryers a production tool. For a free copy, write Pittsburgh Lectrodryer Corporation, 335 32nd Street, Pittsburgh 30, Pennsylvania.

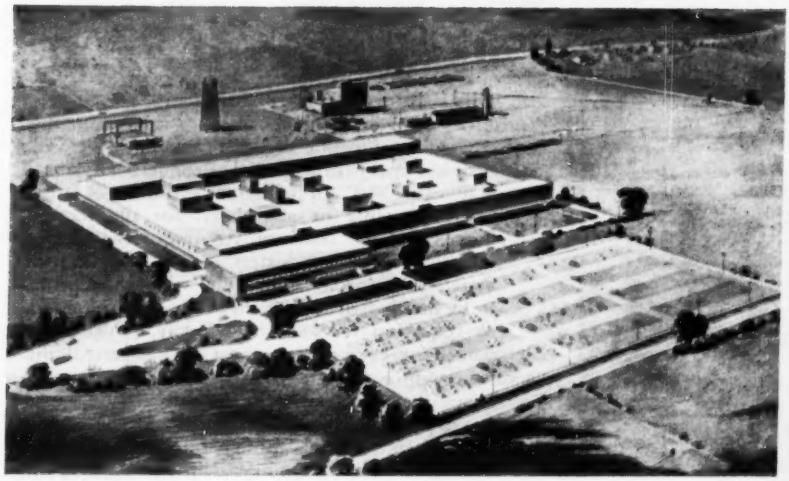
In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Pue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

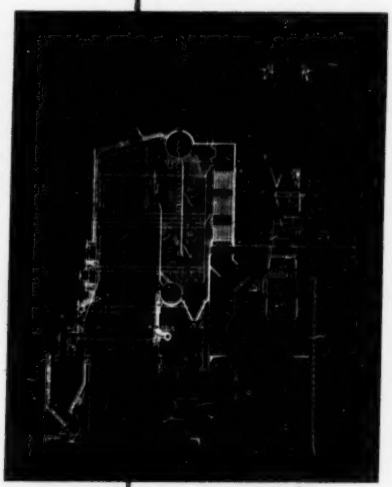
LECTRODRYER

*REGISTERED TRADEMARK U.S. PAT. OFF.

TWO WICKES STEAM GENERATORS will help heat the CATERPILLAR TRACTOR CO.'s new plant at York, Pa.



CONTRACTORS: Consolidated Engineering Company Inc., Baltimore, Md.
CONSULTING ENGINEERS: Whitman, Requardt & Associates, Baltimore, Md.



The Caterpillar Tractor Co., one of the world's largest manufacturers of earth moving equipment, will shortly open their new York, Pa. plant where several hundred men will turn out track assemblies for world famous Caterpillar D6, D7 and D8 Tractors. In this modern manufacturing facility, Caterpillar has installed two 80,000 lb. WICKES steam generators to obtain efficient, economical heat throughout the 360,000 sq. ft. structure. These Type R 2-drum WICKES boilers have a design pressure of 200 psi. and are equipped with economizers and spreader stokers. ✓ ✓ WICKES can fill your requirements for steam generators up to 250,000 lbs. per hour and 1000 psi. — all types of multiple drum boilers, adaptable to any standard method of firing: oil, gas, underfeed or spreader stoker. Consult your nearest WICKES representative or write us today for descriptive literature.

145

WICKES

THE WICKES BOILER CO., SAGINAW, MICHIGAN • DIVISION OF THE WICKES CORPORATION

RECOGNIZED QUALITY SINCE 1854 • SALES OFFICES: Atlanta • Boston • Buffalo • Chicago • Cincinnati • Cleveland • Denver • Greensboro, N.C. Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New York City • Pittsburgh • Portland, Ore. • Saginaw • Springfield, Ill. • Tampa Tulsa • Washington, D. C.

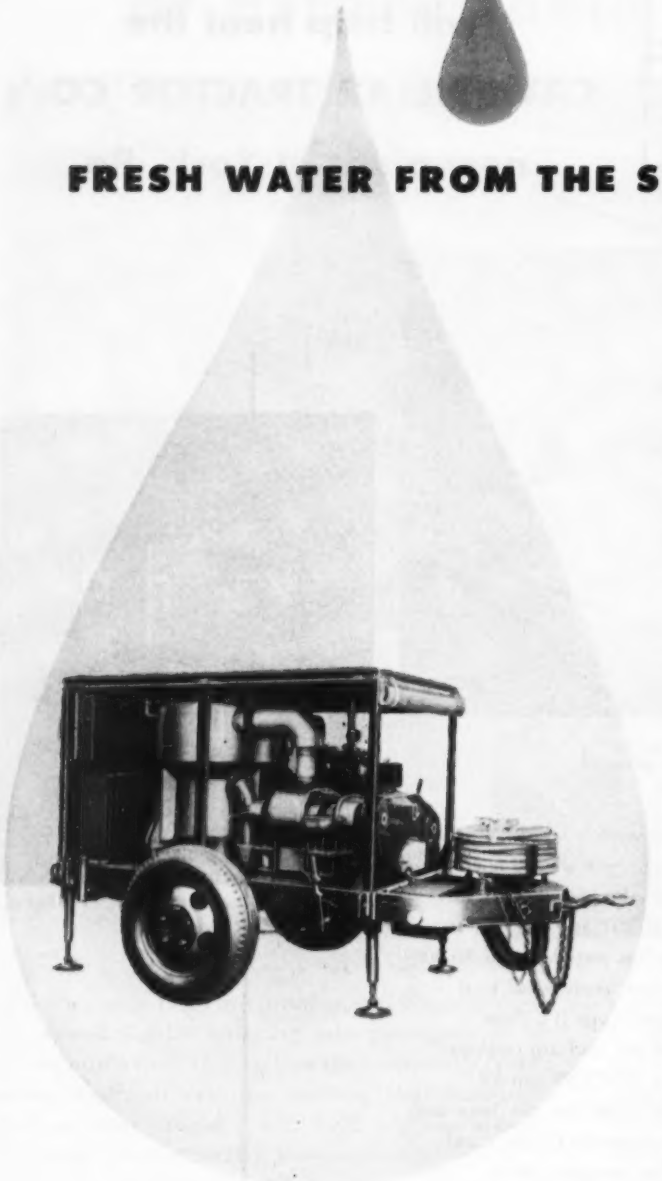
FRESH WATER FROM THE SEA . . . ?

USE REVERE METALS!

This is a portable compression still, which produces pure distilled water from the sea at the rate of 85 gallons per hour. It is made by Cleaver-Brooks Company, Special Products Division, Waukesha, Wis., an important producer of stills, either portable or stationary, for the Armed Forces and for industry. An important feature of Cleaver-Brooks design is the selection of metals in accordance with the water conditions to be met, whether salt, brackish, contaminated, or requiring recovery of valuable by-products. Thus, for example, the heat exchanger, of the tube-within-a-tube type may have cupro-nickel tubes and headers, or Admiralty tubes, naval brass, silicon bronze, according to the nature of the service. Such care in selection of metals is in part at least responsible for the high reputation Cleaver-Brooks enjoys.

In addition to supplying Revere Metals, we were also requested to collaborate with engineers and production men on fabrication methods, including forming, brazing, welding and annealing. Cleaver-Brooks is a large and well-staffed company, and its experience is such that it is capable of conducting its operations unassisted. However, like so many companies, it likes to have others double-check its conclusions and methods, to protect itself and its customers. The Revere Technical Advisory Staff was glad to respond to the call.

Such work is typical of the collaboration Revere offers to you through its salesmen, its Technical Advisors, and the Research Department. Remember, we do not take the place of your own engineers, designers and production people; we consult with them, and make our knowledge freely available, on a confidential basis, of course. Call the nearest Revere Sales Office. Consult your telephone book or write direct.



Portable Diesel-driven sea-water compression still, producing 85 gallons of pure water per hour. Made by Cleaver-Brooks Company, Special Products Division, Waukesha, Wis., which also makes stationary installations for chemical, paper, pharmaceutical and similar plants, for production of pure water or recovery of valuable by-products.

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COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere

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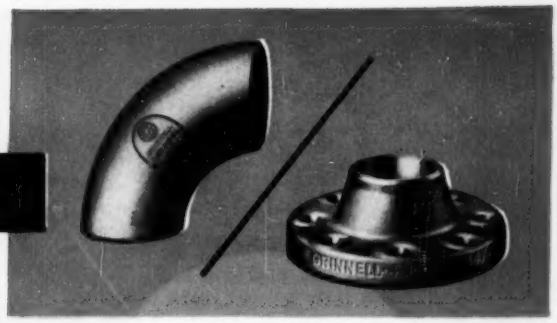

GRINNELL

STAINLESS STEEL WELDING FITTINGS and FLANGES

To help combat mounting costs in the installation and maintenance of piping systems where corrosive or certain other service conditions are involved, Grinnell offers a comprehensive range of welding fittings and flanges in stainless steel.

- **To prevent corrosive attack.**
- **To obtain adequate impact resistance at low temperatures and sufficient creep strength at high temperatures.**
- **To provide sanitary conditions.**
- **To avoid contaminating the product.**

Grinnell welding fittings and flanges are available in types 304, 347 and 316. These are in the chromium-nickel grades known as "18-8". The corrosion resistant properties of stainless steels are primarily due to the chromium content which ranges from 17% to 20%. The addition of nickel in ranges from 7% to 14% improves the corrosion resistance as well as the properties at elevated temperatures. A molybdenum addition of 2% to 3%, as found in type 316, increases the resistance to sulphurous and phosphoric acids, brine and hypochlorite solutions, and improves the general resistance to other corrosive liquids, as well as improving the physical properties at elevated temperatures. A columbium addition of approximately 0.4% to 1.0%, as found in type 347, creates non-susceptibility to carbide precipitation which can cause intergranular corrosion.

In addition to stainless steel, Grinnell offers welding fittings and flanges in carbon steel, nickel, Inconel, Monel, aluminum and brass.

Write for new booklet giving complete data on Grinnell stainless steel welding fittings and flanges. No obligation.

stainless steel welding fittings
Types 304, 347, 316

DESCRIPTION	SCHEDULE†	PIPE SIZE, IN.‡
90° Long Radius Elbow 45° Long Radius Elbow 180° Long Radius Return Straight Tee	5s, 10s, 40s, 80s	½ to 12
Reducing Tee	5s, 10s, 40s, 80s	¾ to 12
Cross (Straight and Reducing)	5s, 10s, 40s, 80s	1¼ to 12
Concentric Reducer Eccentric Reducer	5s, 10s, 40s, 80s	¾ to 12
Lateral (Straight or Reducing)	5s, 10s, 40s, 80s	1 to 12
Cap	5s, 10s, 40s, 80s	½ to 12
Lap Joint Stub End-Long	10s, 40s, 80s	½ to 12
Lap Joint Stub End-Short	5s, 10s, 40s,	½ to 12

† 5s is Featherweight, 10s Lightweight, 40s Standard, 80s Extra Strong.
‡ Larger sizes available on special order.

stainless steel flanges

150 lb. and 300 lb. Steel Flange Standard *(Higher series available on application).*

DESCRIPTION	PIPE SIZE, IN.
Welding Neck Slip-on Lap Joint Threaded Socket Type Blind	½ to 24

150 lb. Corrosion Resistant Standard. *(For use with schedule 10s and 5s pipe. Rated at 150 psi at 500°F, 225 psi at 150°F, when used with full-faced gaskets).*

DESCRIPTION	PIPE SIZE, IN.
Buttwelding Slip-on Blind	½ to 12

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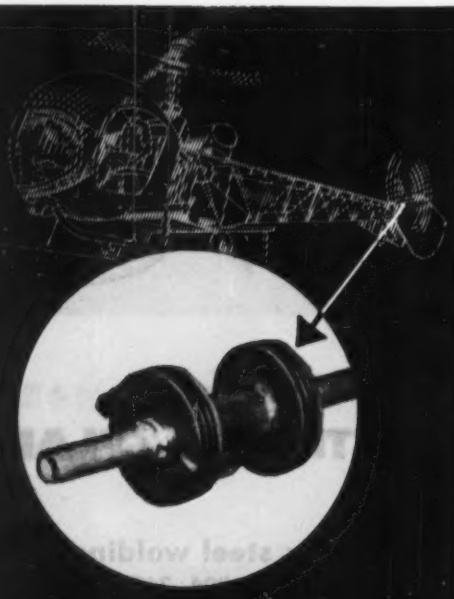
WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • **Coast-to-Coast Network of Branch Warehouses and Distributors**

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems



easier assembly... economical maintenance... with Linear "O" Rings

Linear O Rings perform an unusual job in Bell Aircraft helicopters. The bearing in the tail rotor drive was supported in a metal housing which, because of the metal-to-metal fit, was extremely difficult to install and remove.

By using Linear O rings for mounting the housing, replacement is made easier, maintenance simpler and less costly and a neater, more satisfactory installation is provided.

In many other parts of the helicopter, Linear O Rings provide tight-fitting, space-saving seals.

Whenever you need a fool-proof seal, why not consult the Linear Engineering Staff. Write or call Linear today for full information.

"PERFECTLY ENGINEERED PACKINGS"

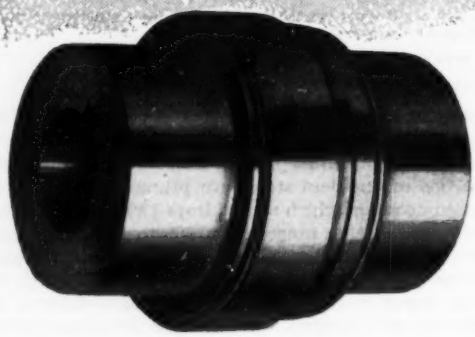
LINEAR

LINEAR, Inc., State Rd. & Levick St., Philadelphia 35, Pa.

THIS NEW SPRING!

Adds 50% to Safe Top Speeds of

LOVEJOY FLEXIBLE COUPLINGS



A new multiple leaf spring holds the collar in place — enables this Lovejoy Coupling to withstand considerably higher speeds with complete safety. Free-floating load cushions suspended between heavy metal jaws — no metal-to-metal power transmission. Instant adjustment for shock, vibration, surge, backlash and misalignment. No lubrication needed. Cushions available for every duty . . . 1/6 to 2500 h.p.

WRITE TODAY FOR COMPLETE CATALOG AND QUICK-FINDING SELECTOR CHARTS.

LOVEJOY FLEXIBLE COUPLING CO.

5032 W. Lake Street Chicago 44, Illinois

Also Mfrs. Lovejoy Universal Joints and Lovejoy Variable Speed Transmissions

TREASURER . . .

WHAT *HE* THINKS OF YOUR TANKS?

(A POSEY IRON Bid Might Interest Him and YOU)

Most treasurers are apt to put cost first. And cost is certainly *not* the only factor to consider when buying steel plate construction.

But —

It's good engineering as well as good financial policy to refuse to pay a penny more for tanks . . . or pressure vessels . . . or stacks . . . than is necessary fully to meet *the standard desired.*

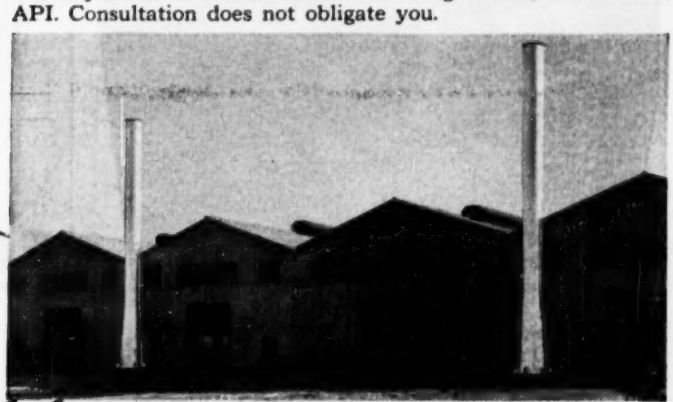
The Posey Iron Works offers you 42 years of money-saving experience over the full range of steel plate fabrication . . . *practical* engineering and design service that concentrates on structural integrity and safety rather than on cost-padding "frills".

That's why we say a Posey Iron bid might interest your treasurer as well as you.

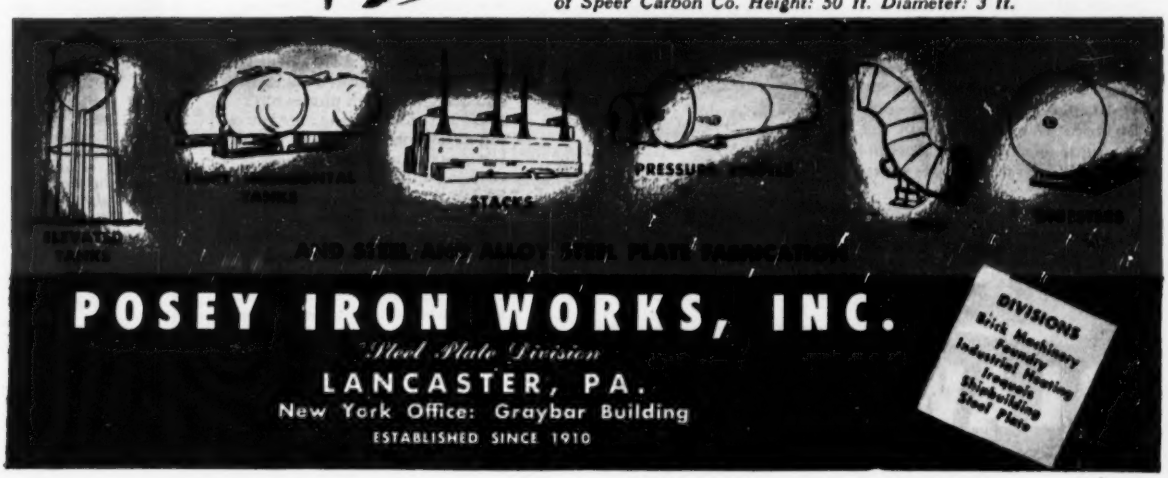
Edges of Plates Properly Prepared for Welding . . .
Electrodes Carefully Selected

Perhaps more than any other production step, welding influences tank costs and structural soundness. Every electric welder in Posey's shops is fully qualified. No plate is welded without proper preparation of edges . . . electrodes are chosen after careful consideration of requirements.

Posey meets all standard codes including **ASME; API-ASME; API.** Consultation does not obligate you.



Posey Iron Works self-supporting stacks installed at the Niagara Falls Plant of the International Graphite & Electrode Division of Speer Carbon Co. Height: 50 ft. Diameter: 3 ft.



POSEY IRON WORKS, INC.

Steel Plate Division

LANCASTER, PA.

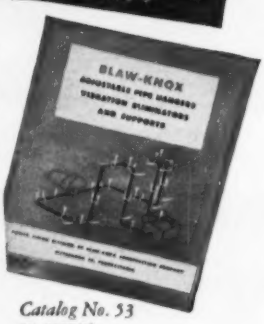
New York Office: Graybar Building

ESTABLISHED SINCE 1910

All Movements Under Control with

BLAW-KNOX OVERHEAD ROLLER ASSEMBLIES

Type 9 Functional Assembly (illustrated) provides free rolling action in two directions and freedom of movement in three—lateral, vertical and horizontal. Its *internal swivel* action gives full control over all movements, and minimizes absorption of piping thrusts by the connecting flanges . . . a big help in keeping maintenance and replacement costs at rock bottom. Available for all standard size piping. Accommodates operating loads up to 12,000 lbs.



Catalog No. 53 on request.

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BLAW-KNOX COMPANY
PITTSBURGH 33, PA.

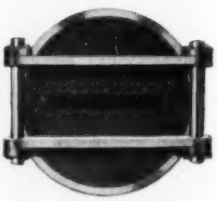
BLAW-KNOX

THE NEW LENAPE-LACY quick opening tight sealing MANWAY

Remove one pin—and swing it open! Close—drop the pin in place—it's sealed!

Here is a manway that can be opened in a few seconds—yet can't open accidentally. The Lenape-Lacy design also *provides positive sealing* which seats more tightly with increasing pressure; and the molded *gasket* of Hycar or Silicone rubber can be *instantly removed and quickly replaced.* A lip protects the gasket seat from damage.

Four frame styles are available for all normal mounting conditions in sizes (ID) of 16″, 18″, 20″, 24″, and 30″ in service ratings of 150 lb., 300 lb., 400 lb., and 500 lb. Also available for pressure-vacuum cycle service.



Write today for Bulletin 523 which describes the Lenape-Lacy Quick Opening Manway in detail.

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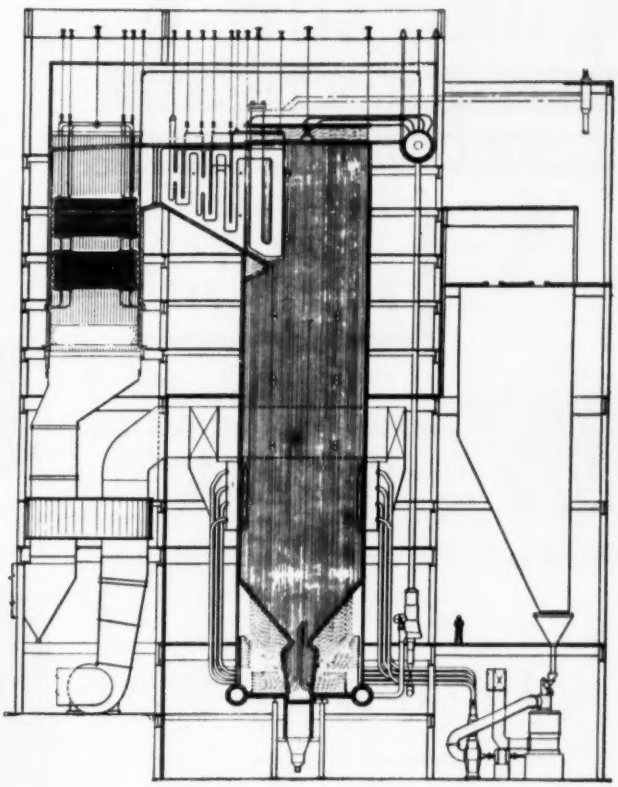
Philadelphia Electric Company

C-E controlled circulation boilers



The C-E Unit shown above is now in process of engineering for the Cromby Station of the Philadelphia Electric Company which will be located in East Pikeland Township, Chester County, Pa.

It is designed to serve a 200,000 kw turbine-generator operating at a throttle pressure of 1800 psi with a primary steam temperature of 1000 F, reheated to 1000 F.

The unit is of the controlled-circulation, radiant type. It is a separated furnace arrangement with secondary superheater surface at the outlet of one furnace and reheater surface at the outlet of the other. Primary superheater sections and economizer surface follow both the secondary superheater and reheater surfaces. Regenerative air heaters follow the economizer surfaces.

Pulverized coal firing is employed, using bowl mills and tilting, tangential burners. Arrangements are made to use oil as an alternate fuel.

B-648

C-E

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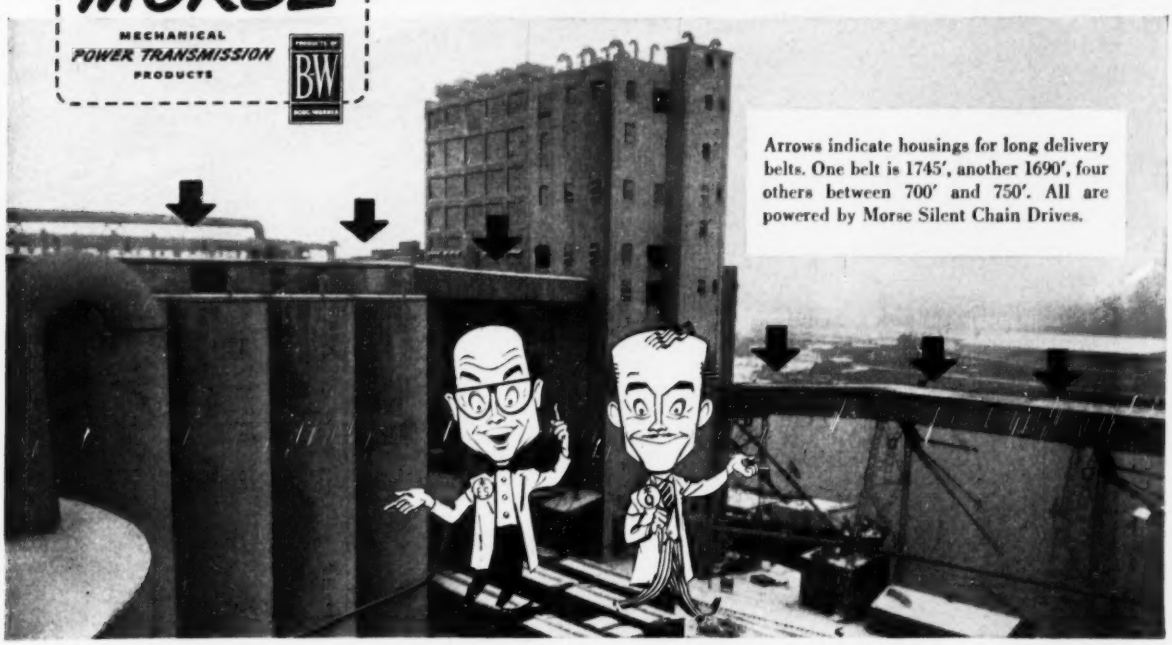
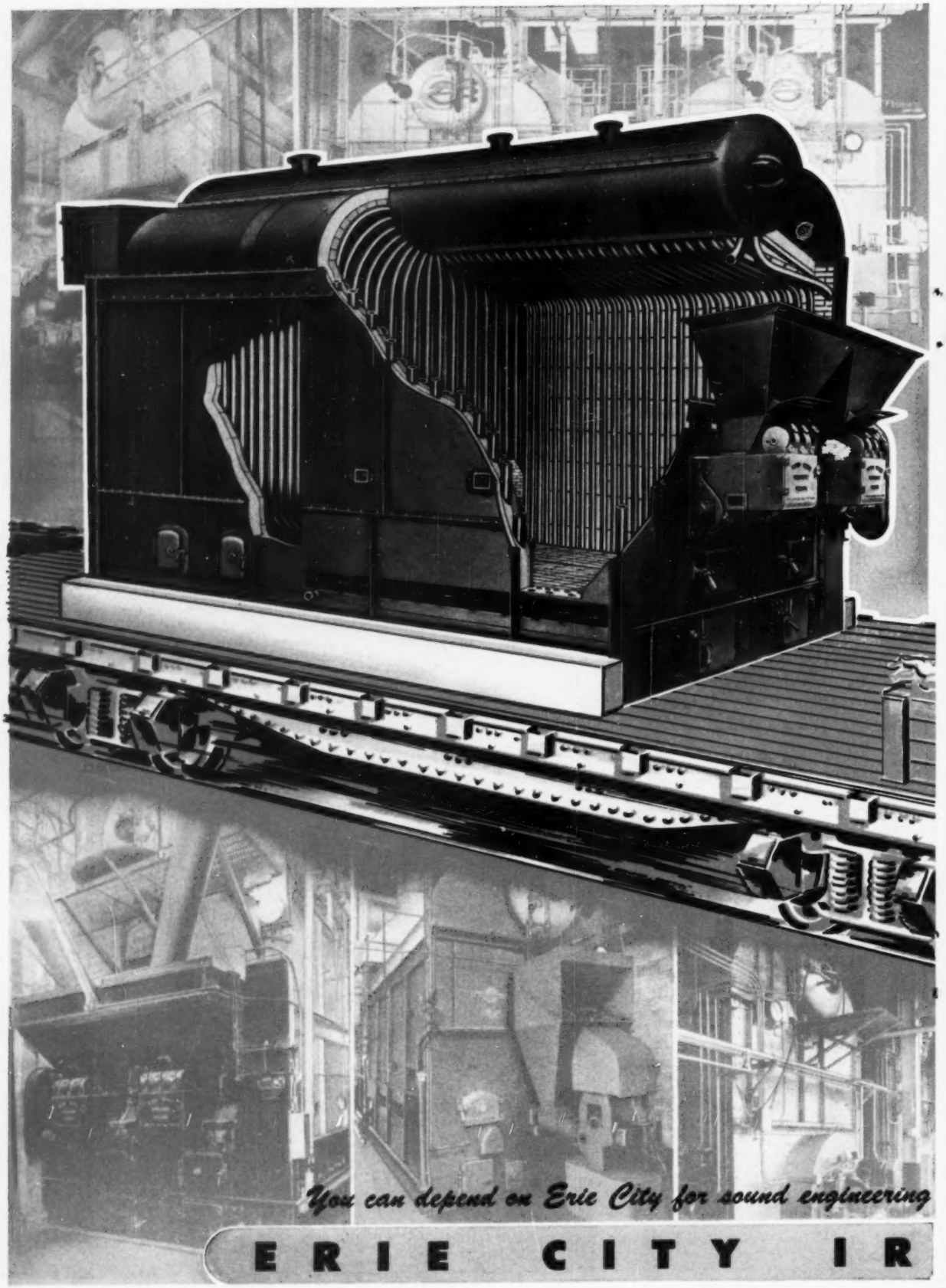


Arrows indicate housings for long delivery belts. One belt is 1745', another 1690', four others between 700' and 750'. All are powered by Morse Silent Chain Drives.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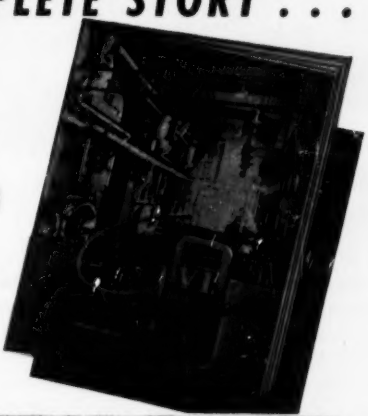

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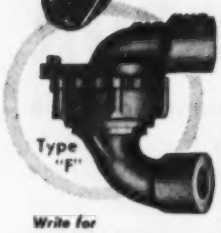

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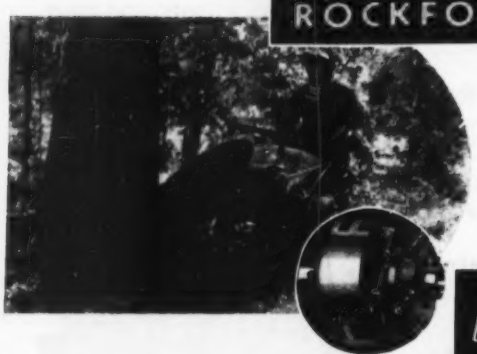

This Saw "Mows 'Em Down Even With the Ground"

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MECHANICAL ENGINEERING

March, 1953 CARD INDEX Vol 75, No. 3

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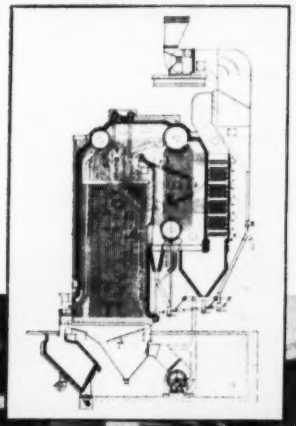

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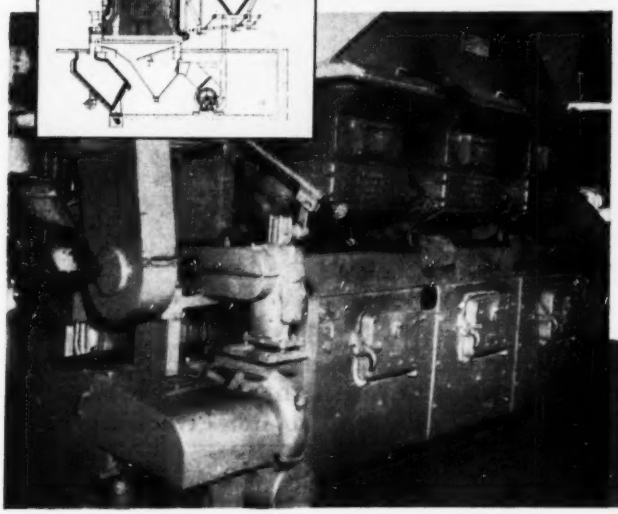
75,000 pound unit with superheater and economizer. 650 pounds pressure 750° F steam temperature. Based on Ohio Strip Mine coal—10,800 BTU.



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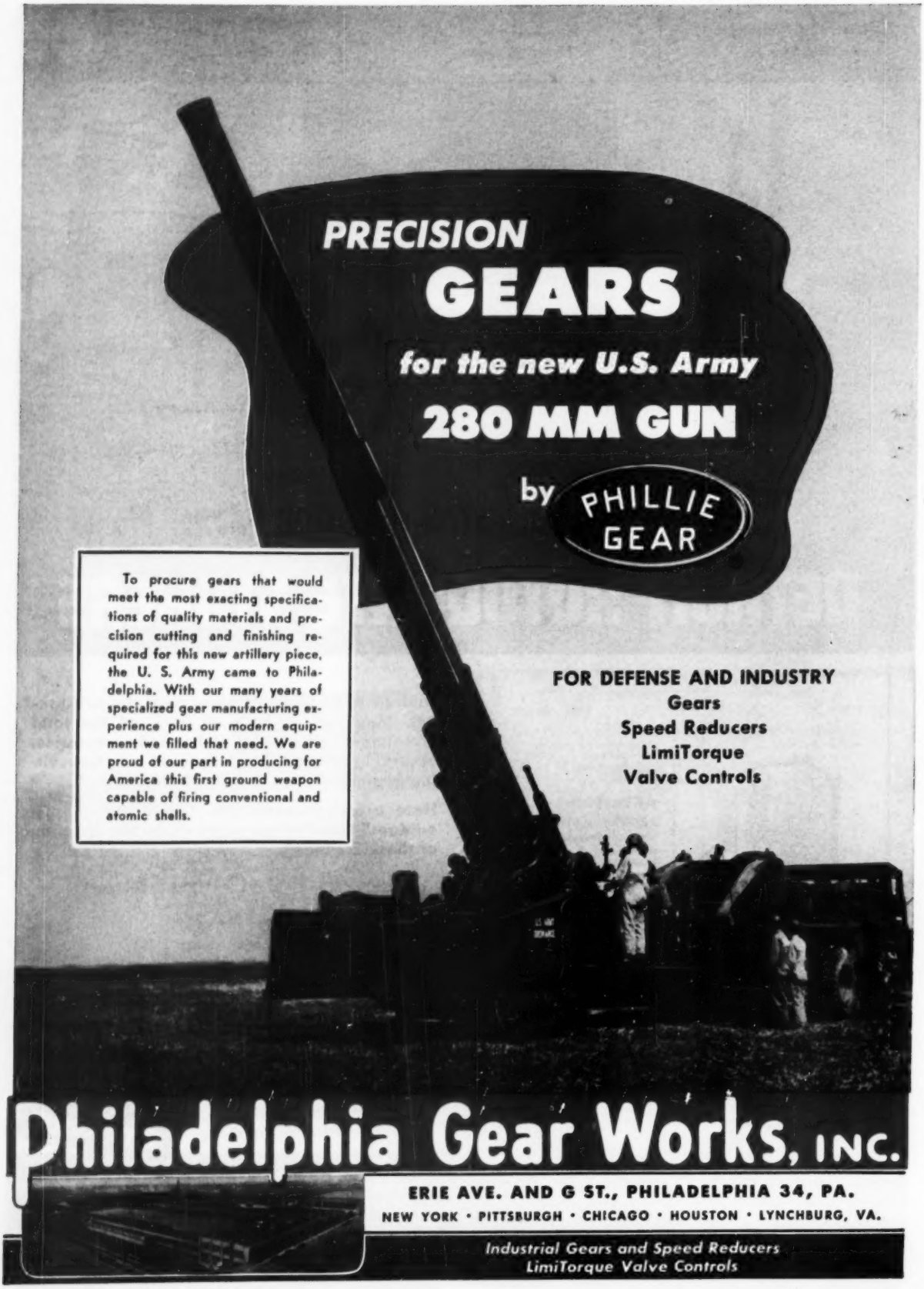
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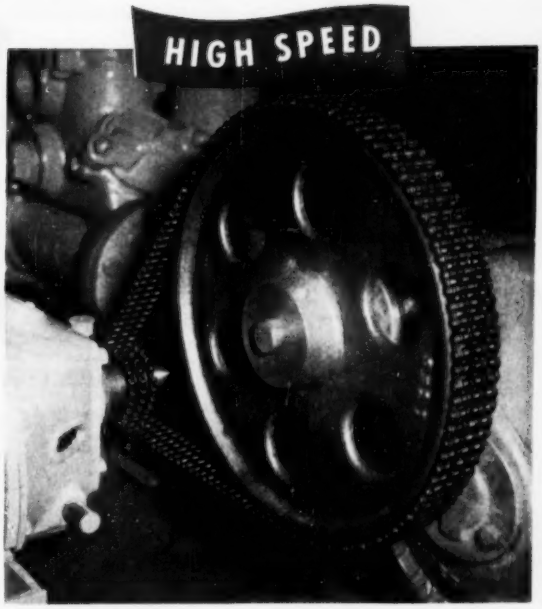

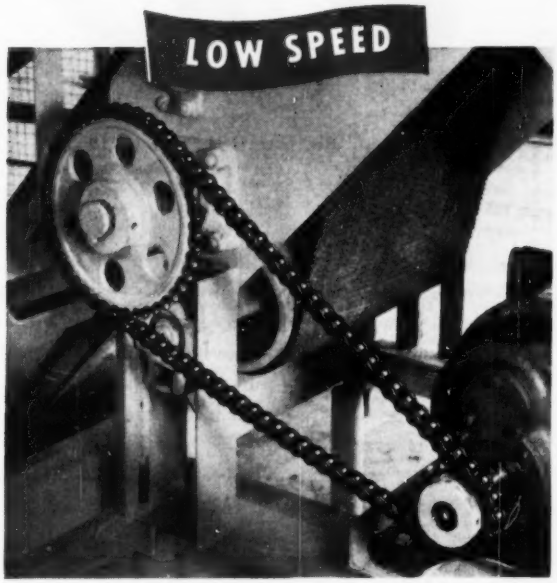

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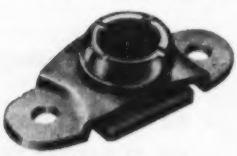

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and requires

PRODUCTION SUPERVISORS AND TECHNOLOGISTS. High pressure experience desirable but not essential.

RESEARCH, PILOT PLANT AND TECHNICAL SERVICE PERSONNEL, with background in polymerization and plastic applications.

Applicants should have Chemical or Mechanical Engineering degree and at least 5 years' experience in chemical or petroleum industry.

Company well known for its progressive policies which include liberal compensation and benefit plans.

Location: ILLINOIS

Address CA-4271, care of "Mechanical Engineering."

Twelve Pages of "OPPORTUNITIES" This Month...153-164

MECHANICAL ENGINEER FOR PRODUCT ENGINEERING

Man with background in roller chain manufacturing or similar products. Excellent opportunity. Replies will be kept in strict confidence.

Address CA-4280, % "Mechanical Engineering."

FOUNDRY ENGINEER

As an assistant to Plant Engineer of a progressive eastern steel foundry. Must be mechanical graduate and capable of carrying duties in plant engineering, maintenance and construction work. Write giving full details on personal background, experience and salary expected.

Address CA-4273, % "Mechanical Engineering."

ANALYTICAL CHEMIST

Good chemist with experience in copper base alloys required. Ability to work well with other laboratory staff personnel. College education desirable but not essential. Company established 35 years and a leader in brass and copper industry. Salary—open.

Write to: Personnel Department
Mueller Brass Co.
Port Huron, Michigan

EXECUTIVE ENGINEER

We are a well-known 25 year old, medium size precision honing equipment manufacturer in a suburb of St. Louis. We need a mature, executive type engineer with administrative experience to direct our expanding civilian program of product design and development. If you have an analytical approach to design problems, coupled with practical shop experience, are 35 to 45, and can handle the responsibilities of a program such as this, write us now. Include detailed academic and business history with personal data in first letter. All replies will be held in strict confidence.

SUNNEN PRODUCTS COMPANY
7910 Manchester Avenue St. Louis 17, Missouri

MECHANICAL DESIGN ENGINEERS

Positions available for Design Engineers with experience in the design of mechanical equipment used in Blast Furnaces, Open Hearth Furnaces, Sintering Plants, Rolling Mills and other auxiliary plants for the processing and production of iron and steel. These men must have experience in Steel Plant layout as well as the design of equipment involved. These are permanent positions with excellent advancement opportunities for qualified Engineers who are interested in greater accomplishment.

If you qualify and are interested in advancing with a continually expanding organization, write, giving complete resumé of positions held and duties performed, education, age, salary desired, etc., to:

ARTHUR G. McKEE & COMPANY
2300 Chester Avenue
Cleveland 1, Ohio

MECHANICAL ENGINEERS

Outstanding Opportunities

as

STAFF CONSULTANTS

Our Consulting and Research Division offers challenging positions to men with experience, imagination, initiative.

Work with our clients on material-handling problems. Emphasis is on handling, transfer, and storage of solids and fluids for oil-refineries, ore-processing plants, and other process industries. Work also with our production departments on new and improved solutions to these problems.

We prefer men with advanced degrees and eight or more years' experience with material-handling in the process industries.

Please send your resumé to our Personnel Department, Attention R. A. Frank. Your letter will receive immediate action and be kept in strict confidence.

C F BRAUN & CO

Engineers *Constructors* *Consultants*

Serving the Petroleum and Chemical-Process Industries since 1909

ALHAMBRA, CALIFORNIA

DEVELOPMENT ENGINEER

For product redesign and development engineering including follow through from inception through development to actual production in connection with patented process for molecular bonding of dissimilar metals. Wide diversification of products including many commercial applications. Twenty licensees in U. S. and foreign countries.

Excellent opportunity for graduate engineer with a metallic product design and development background. Some metallurgical training or experience preferred but not essential.

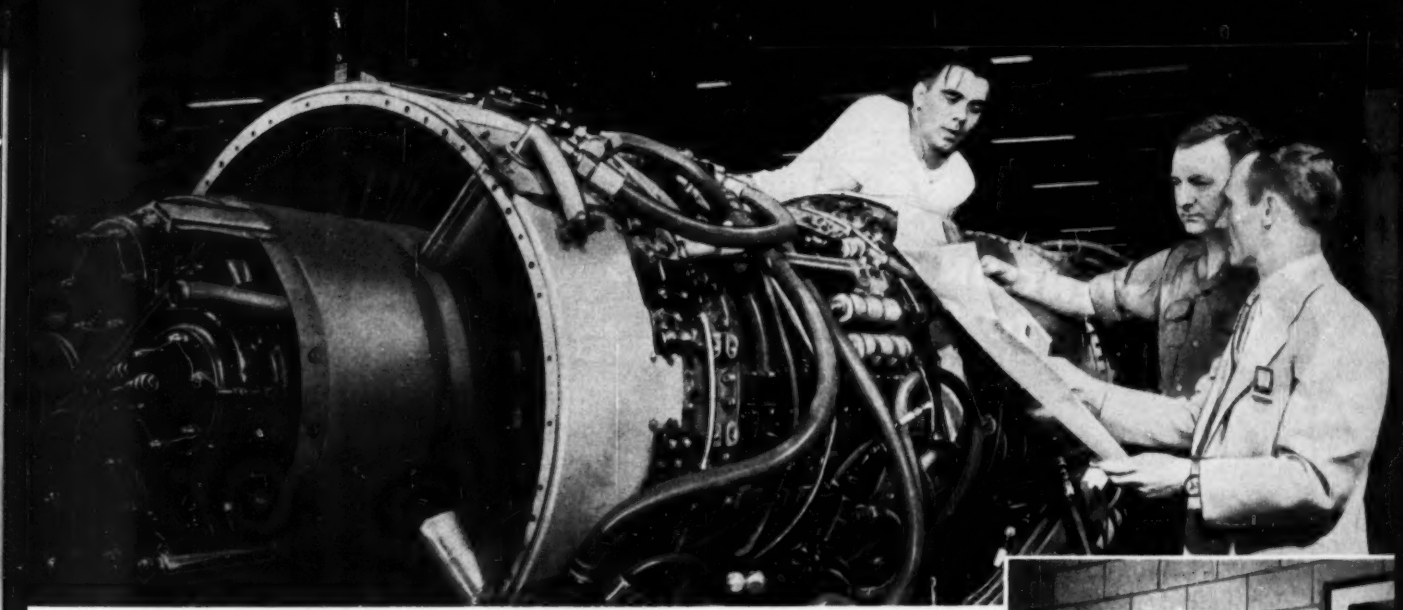
Ideal living conditions on suburban Long Island with all-year recreational advantages including state parks, beaches, golf courses, and boating.

Five-day week, generous company benefits.

Reply stating fully education, experience, age, and salary required.

AL-FIN DIVISION
FAIRCHILD ENGINE & AIRPLANE CORP.
FARMINGDALE, L. I., N. Y.

All replies confidential.



JET EXPERT — Ray Small, right, an Engine Project Manager, keeps close contact with his engineering personnel and with the engines that he is responsible for from development and testing through production and delivery.

JET ENGINES AND YOUR FUTURE

YOU CAN DEVELOP BOTH AT GENERAL ELECTRIC

At General Electric's sprawling Evendale Plant, our engineers are developing and testing advanced jet engines to power America's planes of tomorrow . . . and, at the same time, they are developing solid careers for themselves.

Many of the creative jet engineers now employed at our Jet Center helped G.E. develop this nation's first jet engine 10 years ago.

At General Electric's Aircraft Gas Turbine Division, you, the creative engineer, will have every encouragement, every facility to assist you with engine development problems. Steady advancement and satisfying stability are but a few of the prospects before you with G.E. at Evendale.

If you are interested in a permanent career solving engineering's newest problems, we invite you to match your qualifications with the positions listed below:

AERODYNAMICS	LABORATORY ENGINEERING	LUBRICATION
FLUID MECHANICS	STRESS ANALYSIS	METALLURGY
THERMODYNAMICS	HEAT TRANSFER	FLIGHT MATHEMATICS
TESTING	HYDRAULICS	FIELD ENGINEERING
WELDING	ELECTRONICS	CREATIVE MECHANICAL DESIGN
VIBRATION AND DAMPENING	INSTRUMENTATION	SERVO-MECHANISMS

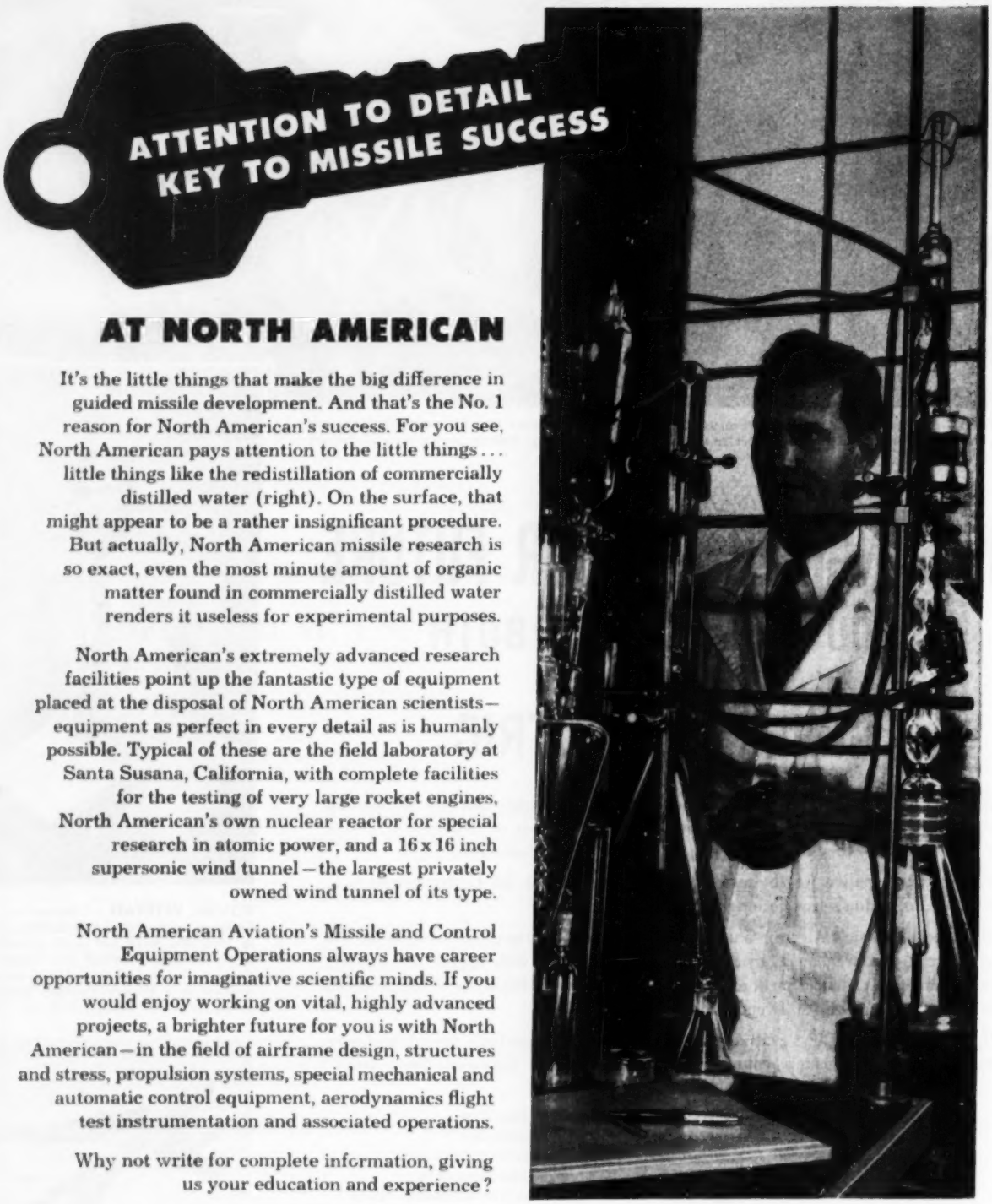
Positions are available at West Lynn, Mass. and Cincinnati, Ohio. Please do not apply if your best skills are being used for vital defense work. Send your resume to: Technical and Supervisory Personnel, Aircraft Gas Turbine Division, Dept.M.

GENERAL ELECTRIC

CINCINNATI 15, OHIO

YOUNG VETERAN — Starting as a Test Engineer in the company's training program in 1940, Mr. Small has made a rapid climb in the company's Aircraft Gas Turbine Division, so that today, he holds a responsible position as a Project Manager, guiding the development of Boeing B-47 jet engines.

STRATEGIC BOMBER — Six G-E jets power this Boeing B-47 medium bomber, which recently set a new speed record from Hawaii to the United States.



AT NORTH AMERICAN

It's the little things that make the big difference in guided missile development. And that's the No. 1 reason for North American's success. For you see, North American pays attention to the little things . . . little things like the redistillation of commercially distilled water (right). On the surface, that might appear to be a rather insignificant procedure. But actually, North American missile research is so exact, even the most minute amount of organic matter found in commercially distilled water renders it useless for experimental purposes.

North American's extremely advanced research facilities point up the fantastic type of equipment placed at the disposal of North American scientists—equipment as perfect in every detail as is humanly possible. Typical of these are the field laboratory at Santa Susana, California, with complete facilities for the testing of very large rocket engines, North American's own nuclear reactor for special research in atomic power, and a 16 x 16 inch supersonic wind tunnel—the largest privately owned wind tunnel of its type.

North American Aviation's Missile and Control Equipment Operations always have career opportunities for imaginative scientific minds. If you would enjoy working on vital, highly advanced projects, a brighter future for you is with North American—in the field of airframe design, structures and stress, propulsion systems, special mechanical and automatic control equipment, aerodynamics flight test instrumentation and associated operations.

Why not write for complete information, giving us your education and experience?

NORTH AMERICAN AVIATION, INC.

Engineering Personnel Section, Missile and Control Equipment Operations
12214 Lakewood Boulevard, Dept. 95-M, Downey, California

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD

MECHANICAL ENGINEER

We need one experienced BS or MS Mechanical Engineer for design, construction and maintenance work in connection with bench scale and pilot plant research in coal processing. This position offers an exceptional opportunity for advancement both in research and in anticipated commercial fields. Replies including education, experience, references, salary desired and recent photograph should be directed to:

Pittsburgh Consolidation Coal Company
Research and Development Division
Library, Pennsylvania
Attention: William F. Saalbach
Advisor on Personnel

MECHANICAL OR AERONAUTICAL ENGINEERING STUDENTS NOW TAKING CO-OP ENGINEERING COURSES

You are studying to be an engineer. *Use* your education while employed in our cooperative training program at Detroit, Michigan. Acquire experience at an engineering level while assigned to projects along with our engineers. Salary commensurate with education. Excellent opportunities in research, design, production, and sales. Write giving details of personal history, school, scholastic standing and desired field of employment.

Address CA-4219, % "Mechanical Engineering."

MECHANICAL DESIGN ENGINEER

To design automatic machines for production of electronic tubes. Five to ten years' responsible experience in design of medium weight automatic machinery required. Vacuum tube equipment experience is desirable but not mandatory.

Permanent position with opportunities for advancement in new and expanding division, not dependent on defense contracts. Interesting and varied projects. Excellent salaries. Attractive working and living conditions, life and health insurance.

WESTINGHOUSE ELECTRIC CORPORATION
ELECTRONIC TUBE DIVISION
P. O. Box 284 Elmira, New York

MECHANICAL ENGINEERS

BENDIX RADIO will suit you to a "T"

We need Mechanical Engineers to work on design of small mechanisms, light structures, gear trains, chassis and packaging units as applied to electronics communications equipment.

Men we want must have M. E. or A. E. degree, with one or more years experience in mechanical design.

Positions involve board design, model shop association and construction-testing of primary models.

You benefit from excellent starting salary, ideal working conditions in modern plant, paid vacations and holidays and good chance for rapid advancement. Housing immediately available in beautiful suburban and country areas that surround the Bendix plant.

Write, wire or phone
MR. E. O. COLE, Dept. M

Bendix Radio
DIVISION OF BENDIX AVIATION CORP.
BALTIMORE-4, MD. Phone: TOWSON 2200

TOP FLIGHT ENGINEER

This is an unusual opportunity in a rapidly expanding company, a leader in its field. We have an opening for a top flight engineer for product design and development. Should have previous experience in either home freezers, room coolers, or household refrigerator engineering.

Pleasant working conditions with many employee benefits.

All replies treated in strictest confidence. Apply General Manager

AMANA REFRIGERATION, INC.
Amana, Iowa

Additional Opportunities are offered in the display advertisements— on pages

47, 57, 114, 116, 142

***READ the* CLASSIFIED ADVERTISEMENTS**
appearing in this section each month.

Twelve Pages of "OPPORTUNITIES" This Month...153-164

PUMP SALES ENGINEERS WANTED

By Nationally Known Manufacturer

Must be experienced in application and sales of positive displacement pumps for industrial plant and O. E. M. requirements. Situations open for traveling home-office specialists and field office engineers in principal industrial areas.

Please give complete details including education, age, experience and earnings record. Confidential.

Address CA-4291, % "Mechanical Engineering."

PRODUCT DEVELOPMENT ENGINEER

Graduate Engineer with creative ability to develop improvements in present products and develop new products in the refrigeration, plumbing and heating field. Technical Degree—Master's or Doctor's. Company established 35 years and a leader in the copper and brass industry. Salary—commensurate with job requirements and applicant's qualifications.

Write to: Personnel Department
Mueller Brass Co.
Port Huron, Michigan

DEVELOPMENT AND EXPERIMENTAL ENGINEERS

Under 30 yrs. of age, aggressive and having a B.S. degree for
Openings in the fields of

ENGINEERING MECHANICS
MECHANICAL ENGINEERING
ELECTRICAL ENGINEERING
GENERAL ENGINEERING
METALLURGICAL ENGINEERING

Sixty-three year old company concerned with the manufacture of Steel Roller Chain for Power Transmission and Conveyor Purposes.

Write our Personnel Director
DIAMOND CHAIN COMPANY, INC.
INDIANAPOLIS 7, INDIANA

MECHANICAL or STRUCTURAL DRAFTSMAN

Experienced draftsman desired who can sense the long-term and increasing opportunity now offered in development of materials handling equipment. Employment is offered in permanent (non-defense) work on overhead electric traveling cranes, hoists and similar equipment, with a long established company now expanding its plant in the mid-west area.

Address CA-4285, % "Mechanical Engineering."

CONSTRUCTION ESTIMATOR *and* COST CONTROL MAN

Must be thoroughly experienced in quantity take-offs and estimating and have successful performance record in competitive bidding. Cost control experience required. Background in Power Plant work, Process Piping and General Industrial Construction absolutely essential. We are looking for a man who has been successful as a Chief Estimator and is seeking a permanent staff position. State education, experience, and salary requirements. All applications will be acknowledged. Location Philadelphia.

Address CA-4294, % "Mechanical Engineering."

MECHANICAL ENGINEER with Machine Design Experience

Permanent position open as assistant to Chief Draftsman of Steam Turbine Company in New England. Experience required in turbine design or similar product. Write giving education, experience and salary expected.

Address CA-4301, % "Mechanical Engineering."

ENGINEERS

Unusual opportunity for rapid advancement and graduate study with vigorous new organization now expanding in field of Ordnance, Electro-Mechanical and Electronic Devices, Aircraft and Missile Launchers and Catapults, Compression Distillation, Servo-Mechanisms, Etc.

DESIGNERS

Challenging positions in creative design of Special Machinery, Turbines, Compressors, Pumps, Ordnance, Controls, Etc.—if you have background experience in Structural, Electrical or Mechanical Design.

DRAFTSMEN

Minimum of 2 years' Drafting and Layout Experience on Electrical and Mechanical Equipment.

. . . BENEFITS

...In-service training...Rapid Professional Development, Premium Pay for Overtime...Permanent Job Security... Aid for Advanced Education...Modern Suburban Office... Free Parking.

. . . LIVE in suburban area...60 minutes from N.Y.C., 30 minutes from Philadelphia, 30 minutes from Seashore ...Superior Housing Facilities can be arranged through our Personnel Department...Moving Allowance.

EARN MORE—SAVE MORE

Work For

POWER GENERATORS LTD.

25 North Montgomery St., Trenton, N. J.

Outstanding Creative Engineers

MECHANICAL ENGINEER

With 5 to 10 years' experience in general machine design. Design of special test equipment preferred but not mandatory. Unusual opportunity to make fast progress and gain quick recognition in an uncrowded industry; diversified work on a wide variety of projects. Company-furnished meals, insurance, hospitalization and medical care. Liberal vacation policy. Plant location Cleveland suburb close to good residential areas. Outline experience and minimum salary requirements in letter. Write Engineering Department No. 3261-27.

JACK & HEINTZ, INC.

CLEVELAND 1, OHIO

HEAT TRANSFER AND COOLING DESIGN ENGINEERS

Two years' or more experience in the field of thermodynamics and heat transfer. Prefer men with MS degree but not mandatory. Permanent, good paying. Company-furnished meals, insurance, hospitalization and medical care. Liberal vacation policy. Air-conditioned quarters. Plant location close to good residential area.

Outline experience and salary requirements in letter to Engineering Department No. 3261-27.

JACK & HEINTZ, INC.

CLEVELAND 1, OHIO

Lockheed Calling Engineers

to a better future...
a better life...
in California

There's more to a job at Lockheed than eight hours' work a day. There's the friendly spirit of progress—of getting things done—that makes work so much more stimulating. There's the better life you live—just because you live in Southern California. There's the future that offers you and your family security and advancement with the *leader in aviation.*

New design ideas spring from spontaneous conferences such as these

Better Working Conditions

On the job, you work in an atmosphere of vigorous, progressive thinking. Personal initiative, new ideas are encouraged. Frequent conferences iron out problems, keep work rolling smoothly. You work with top men in your profession—as a member of the team known for leadership.

Outdoor life prevails in Southern California the year around

Better Living Conditions

Every day, you get a "bonus" at Lockheed—in the better living conditions. The climate is beyond compare. Recreational opportunities are unlimited. Golf, fishing, the patio life at home can be yours 12 months a year. And your high Lockheed salary enables you to take full advantage of the climate and recreational opportunities.

Special training courses prepare you for promotion

Better Future

You have a *future* at Lockheed—not just a job. For Lockheed is building planes for defense, planes for the world's airlines. The planes of tomorrow are being designed today in Lockheed's long-range development program.

Special training courses in management and various phases of aeronautical engineering help prepare you for the future and promotion. Ask any of the 5,000 who wear 10-year pins whether or not there's a career and security at Lockheed.

To Engineers with Families:

Housing conditions are excellent in the Los Angeles area. Thousands of rental units are available. Huge tracts for home ownership are under construction now. Thousands of homes have been built since the last war. Lockheed counselors help you get settled. Educational facilities also are excellent. The school system offers your children as fine an education as can be obtained anywhere. Elementary and high schools are conveniently located. Junior colleges and major universities abound—21 are in the Los Angeles area.

Lockheed also offers:

Generous travel allowances • Outstanding Retirement Plan • Vacations with pay • Low-cost group life, health, accident insurance • Sick Leave with pay • Credit Union, for savings and low-cost financing • Employees' Recreation Clubs • Regular performance reviews, to give you every opportunity for promotion • On-the-job training or special courses of instruction when needed.

IMMEDIATE OPENINGS FOR:

- Aerodynamicists
- Airplane Specifications Engineers
- Ballistics Engineers
- Design Engineers "A" & "B"
- Engineering Drawings Checkers
- Flight Test Engineers "B"
- Flutter and Vibration Engineers
- Instrumentation Engineers
- Jr. Engineers—Draftsmen "A"
- Jr. Engineers—Draftsmen "B"
- Numerical Mathematical Analysts
- Research Engineers
- Scientists for systems analysis and military operations research
- Service Engineers
- Servomechanism Engineers
- Stress Engineers
- Structures Engineers
- Weight Engineers

Send today for free illustrated brochure describing life and work at Lockheed in Southern California. Use this handy coupon.

Mr. M. V. Mattson, Employment Manager, Dept. ME-4

LOCKHEED Aircraft Corporation Burbank, California

Please send me your brochure describing life and work at Lockheed.

My Name _____

My Street Address _____

My City and State _____

My Field of Engineering _____

Aircraft experience is *not necessary* for a job at Lockheed. It's your general engineering background—*your aptitude*—that counts. Lockheed will train you to be an aircraft engineer—*at full pay.*

MECHANICAL ENGINEERS

Experienced in:

Design and Development of Mechanical Systems including experience in

MACHINE DESIGN
STRESS ANALYSIS
MECHANISMS
CAM DESIGN
GEAR AND GEAR TRAINS

ELECTRONIC SYSTEMS ENGINEERS

Experienced in:

Development and Design of Electronic Systems including experience in

SERVO DRIVES
RADAR MICRO WAVE TECHNIQUES
PRECISION TIME MEASUREMENTS
COMPUTERS
GYROS
SYNCHROS
UHF CIRCUITORY

You can aim high at

DAYSTROM INSTRUMENT

a great new division of an old established company...offers challenging assignments and splendid facilities in a magnificent new plant.

Enjoy ideal working and living conditions within 30 minutes driving distance of world-famous winter and summer resorts ... only three hours from New York or Philadelphia.

Salary in line with ability. Modern benefits program. Interview and moving expenses paid.

Contact PERSONNEL DEPARTMENT

A DIVISION OF DAYSTROM, INCORPORATED
ARCHBALD, PENNSYLVANIA

DAYSTROM
Instrument Division

Affiliated Companies: American Type Founders, Inc. • Daystrom Electric Corporation • Daystrom Furniture Division

Major company in diversified industry requires engineers wih B.S. degrees in Chemical, Mechanical and Civil Engineering.

Plants located in widespread area, with many in midwest. Excellent opportunities for advancement. Equitable welfare policies and salaries.

Please reply giving details of education, experience and salary requirements. Replies will be held in strict confidence.

Address CA-4274, % "Mechanical Engineering."

AC SPARK PLUG DIVISION OF GENERAL MOTORS CORPORATION

PRECISION INSTRUMENT PLANT

Positions now available for highest caliber personnel in the field of airborne automatic electro-mechanical control equipment.

MECHANICAL DESIGN ENGINEERS
ELECTRONIC ENGINEERS
SERVO ENGINEERS
ELECTRONIC DESIGNERS
MECHANICAL DESIGNERS

New and expanding division of an established firm with 20 years of successful experience in the instrument field. Work involved deals with the manufacture and development of highly complex equipment of the most advanced type.

Write or Apply

AC Spark Plug Division
General Motors Corporation
1925 E. Kenilworth Place
Milwaukee 2, Wisconsin

It will pay you to watch the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

TO ELECTRO-MECHANICAL ENGINEERS AND DESIGNERS

with experience in

SMALL, PRECISION DEVICES

HUGHES RESEARCH AND DEVELOPMENT LABORATORIES, one of the nation's leading electronics organizations, is now creating a number of new openings for qualified electro-mechanical engineers and designers in important phases of its operations.

HOW TO APPLY

Write today to address below, giving details of qualifications and experience. Assurance is required that any relocation of an applicant will not cause disruption of an urgent military project.

THE COMPANY

The Hughes Laboratories, located in Southern California, are presently engaged in the development and production of advanced radar devices, electronic computers and guided missiles.

THE OPPORTUNITIES

Opportunities are offered for men who will perform interesting work on development of intricate new devices in close association with outstanding scientists. Activities will embrace a variety of challenging problems requiring originality and affording unusual possibilities of progress in learning.

FIELDS OF WORK

The work includes such fields as those involving Servo Mechanisms, Computers, Microwave Tubes, Pulse Circuitry, Solid-State Physics, Miniaturization, Antennas—Waveguides, Heat Transfer, Hydraulics—Gyros, Test Equipment, Subminiaturization, Stress Analysis, Instrumentation, Structures, and Precision Production Mechanisms.

YOUR FUTURE

Working experience in advanced techniques employing the above fields will increase your value to the Company as it further expands in development of electro-mechanical devices. Large-scale use of electronically controlled systems in business and industry is a certainty within the next few years.

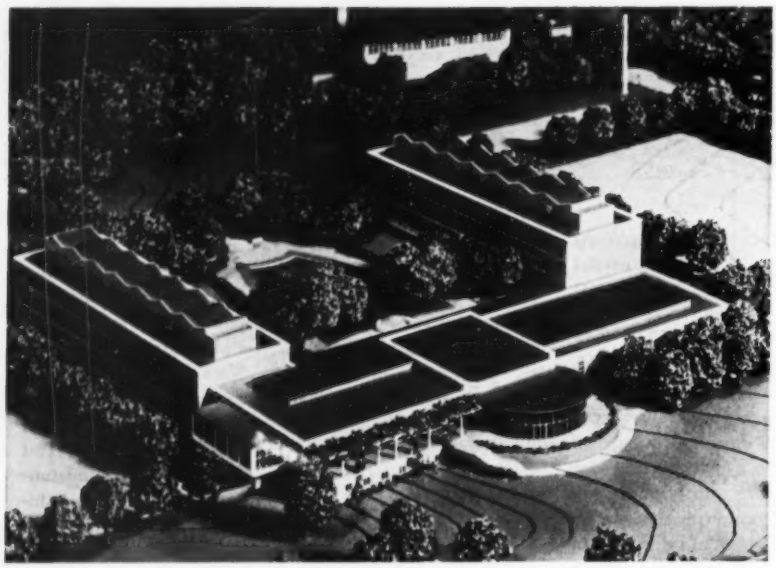
HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

SCIENTIFIC AND ENGINEERING STAFF
CULVER CITY, LOS ANGELES COUNTY, CALIFORNIA

IBM *Announces*

A Great New Engineering Research Laboratory



Model of new IBM Research Laboratory now under construction at Poughkeepsie, N. Y.

In this building, ideas will be born, developed, and become part of America's future. Here, engineers and scientists will have facilities for creative work such as were undreamed of yesterday.

In IBM's other fine engineering laboratories in Poughkeepsie and Endicott, N. Y., and San Jose, Cal., engineers and scientists are working on exciting projects for the future. These include electronic digital computers, electronic and electric business machines and time systems, and electric typewriters.

IBM's continuous program of research, development, and manufacture has created a constant flow of new services for business, industry, science, and the nation.

Today there are opportunities in IBM for development engineers, physicists, and design engineers. You are cordially invited to investigate these opportunities. Inquiries should be directed to Mr. W. W. McDowell, Director of Engineering, International Business Machines, Room 165, 590 Madison Avenue, New York 22, N. Y.

MECHANICAL ENGINEER

Responsible permanent position in new section of established company.

Graduate, age 35–50, experienced in chemical industry design including pressure vessels, piping, materials and specifications.

Paid holidays . paid vacation . low cost group health, accident, and life insurance . retirement plan.

Salary commensurate with ability and experience.

Submit resumé of personal history . education . experience . salary expected.

Application confidential.

DIRECTOR OF DEVELOPMENT
NITROGEN DIVISION
ALLIED CHEMICAL & DYE CORPORATION
ORGANIC DEPARTMENT
HOPEWELL, VIRGINIA

ENGINEERS DESIGNERS SPECIALISTS

Positions available for men with several years' experience. Assignments involve design of power plants, aeronautical test facilities and general industrial facilities. Desire adequate background in any of these fields:

- **Aerodynamic design of advanced test facilities and associated equipment.**
- **Compressible gas process engineering.**
- **Heating and ventilating and air conditioning design and layout and equipment selection.**
- **Heat transfer calculations and equipment selection.**
- **Industrial process plant engineering.**
- **Mechanical equipment selection and specifications. Bid evaluations.**
- **Piping design and layout.**
- **Pipe stress analysis.**
- **Power plant engineering.**
- **Pressure vessel design.**
- **Process controls design. Familiarity with valves and hydraulic, pneumatic and electrical operators desired.**

Sverdrup & Parcel, Inc. was established in 1928 and employs over 600 people. Unusual engineering opportunities exist with our well established firm in connection with the design of a variety of engineering projects including advanced aeronautical test facilities, bridges, buildings, power plants, transmission lines and general industrial facilities.

Please write fully to—

SVERDRUP & PARCEL, INC.
CONSULTING ENGINEERS
915 Olive **St. Louis 1, Mo.**

It will pay you to watch the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

MECHANICAL AND ELECTRICAL
SPECIFICATIONS WRITER

Large engineering and construction firm engaged in central station, industrial, and chemical work has permanent staff position open for graduate mechanical and electrical engineer familiar with specifications writing. While many years of experience are highly desirable, your merit and ability will be given full consideration.

Salary commensurate with experience and ability. Excellent working conditions and liberal company benefits.

Applicants please give full details including personal data, education, experience and salary desired in your reply.

Address CA-4253, % "Mechanical Engineering."

ENGINEERS AND DESIGNERS

with creative ability and a sincere interest in stable employment wanted by a medium size well-known machine tool company. Openings exist in research, machine design and equipment design divisions due to present and projected design of new products. Applicants with working knowledge of machine hydraulics, servomechanisms and electrical components desired. Company is located in a pleasant, progressive New England village having good recreational facilities, modern schools, hospital, etc. Excellent working conditions and congenial atmosphere.

Address CA-4199, % "Mechanical Engineering."

ENGINEERS
AND
PHYSICISTS
BS-MS-PH.D.

Responsible positions in mechanical, electrical or electronic engineering, physics or engineering physics for advanced development and design of special equipment and instruments. Prefer men with minimum of two years' experience in experimental research design and development of equipment, instruments, intricate mechanisms, electronic apparatus, optical equipment, servomechanisms, control devices and allied subjects. Positions are of immediate and permanent importance to our operations. Southwestern location in medium sized community. Excellent employee benefits. Reply by letter giving age, experience and other qualifications. All applications carefully considered and kept strictly confidential. Ind. Rel. Manager, Research & Development Dept.

PHILLIPS
PETROLEUM COMPANY
Bartlesville, Oklahoma

Use a CLASSIFIED ADVERTISEMENT
For QUICK RESULTS

ENGINEERS
FOR ATOMIC
WEAPONS INSTALLATION

Mechanical Engineers, Electronics and Electrical Engineers, Physicists, Aerodynamicists, and Mathematicians. A variety of positions in research and development open for men with Bachelors or advanced degrees with or without applicable experience.

These are permanent positions with Sandia Corporation, a subsidiary of the Western Electric Company, which operates the Laboratory under contract with the Atomic Energy Commission. The Laboratory offers excellent working conditions and liberal employee benefits, including paid vacations, sickness benefits, group life insurance and a contributory retirement plan.

LOCATE IN THE
Healthful Southwest

Albuquerque, center of a metropolitan area of 150,000, is located in the Rio Grande Valley, one mile above sea level. Albuquerque lies at the foot of the Sandia Mountains which rise to 11,000 feet. Cosmopolitan shopping centers, scenic beauty, historic interest, year 'round sports, and sunny, mild, dry climate make Albuquerque an ideal home. New residents experience little difficulty in obtaining adequate housing in the Albuquerque area.

APPLICATIONS NOW BEING ACCEPTED
FOR TECHNICAL WRITERS
•
These are not Civil Service Appointments

Make Application to the
PROFESSIONAL EMPLOYMENT DIVISION

SANDIA
Corporation
SANDIA BASE
ALBUQUERQUE, N. M.

Twelve Pages of "OPPORTUNITIES" This Month...153-164

POSITIONS OPEN

CENTRIFUGAL COMPRESSOR ENGINEER

Senior and junior engineers for design and development of industrial air, gas and refrigeration compressors. Analysis of existing designs including performance calculations for special applications. Have thorough knowledge of modern centrifugal compressor design practice, particularly as applied to multi-stage compressors. Address replies stating qualifications, complete personal data, resumé of experience and salary expected, to:

Employment Manager
CARRIER CORPORATION
SYRACUSE, NEW YORK

DESIGN AND DEVELOPMENT ENGINEERS—Upstate New York manufacturer requires two mechanical engineers with five to ten years' experience in machine design, or pressure vessel design. A challenging opportunity is offered to men with creative ability by this expanding medium size company with an international reputation. All employees receive an extensive program of benefits. Our employees know of this advertisement. Send a complete resumé, including experience, salary requirements, and education. Address CA-4292, care of "Mechanical Engineering."

A SALESMAN for a nationally known Pipe Fabricating and Erecting Company. College graduate in Engineering, plus knowledge of the piping industry required. Person desired: Approximately 35 years of age and willing to do extensive traveling. Good salary and expenses. Address CA-4298, care of "Mechanical Engineering."

DESIGN ENGINEER—We are seeking a design engineer of sufficient experience and stature to assume responsibilities for a design section composed of engineers and draftsmen. This man must be familiar with stress analysis, know how to lead men and generally display sound mature judgment. Current design problems include high speed propeller assemblies, wind tunnel models, and complex mechanical instrumentation. The opportunity for experience and growth in administrative and technical matters is excellent. Employment Manager, Cornell Aeronautical Laboratory, Inc., Buffalo 21, New York.

ASSISTANT or ASSOCIATE PROFESSOR MECHANICAL ENGINEERING—Duties, to instruct undergraduate students and develop post-graduate work. Time and facilities for research. Qualifications: University graduate, preferably some post-graduate training. Several years' practical experience which may include industrial graduate engineer training course. Classification of appointee will depend upon qualifications of successful applicant—apply Nova Scotia Technical College, P. O. Box 1000, Halifax, Canada.

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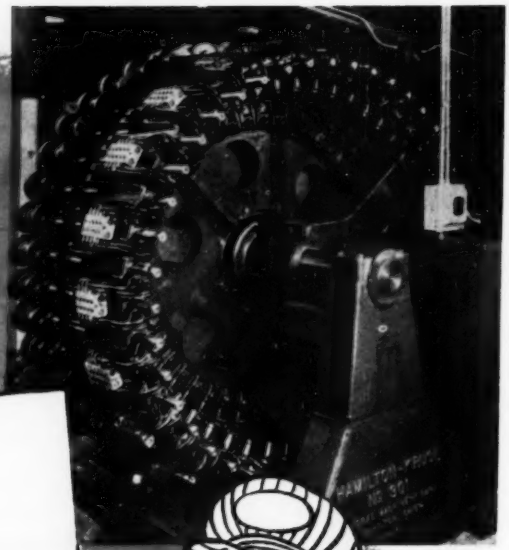

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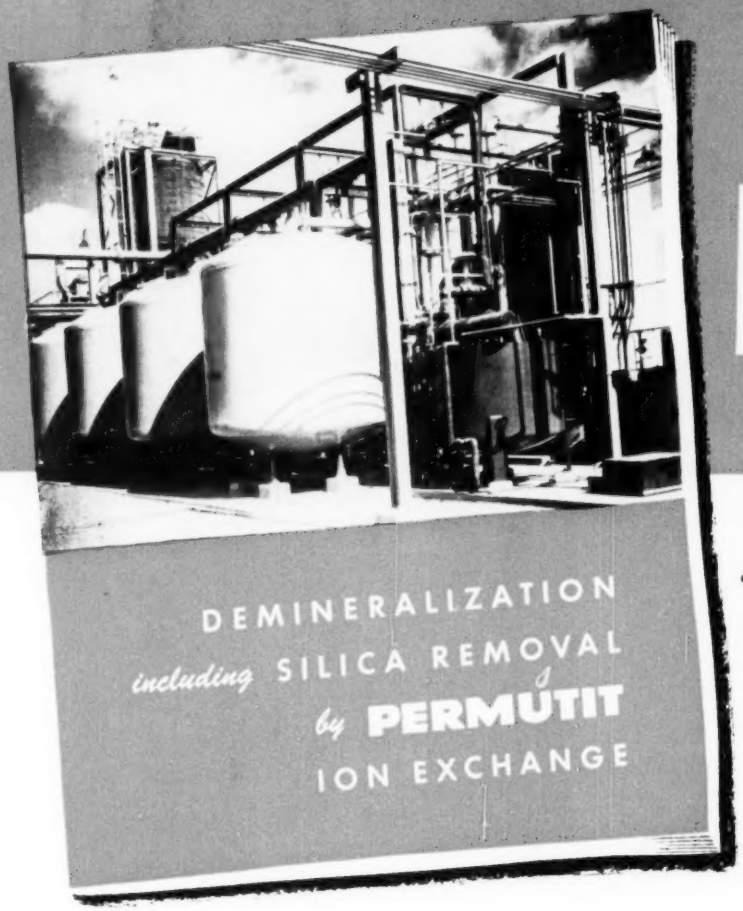

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Restores worn car wheels automatically

. . . with help of TIMKEN® bearings

THIS Niles 52″ car wheel lathe, manufactured by Baldwin-Lima-Hamilton Corporation, roughs and finishes worn car wheels automatically—all in one operation! A hydraulic stylus follows a predetermined contour of the profile. Special micrometers and calipers measure and gage the wheels to determine the amount of material to be removed in re-profiling the wheel contours.

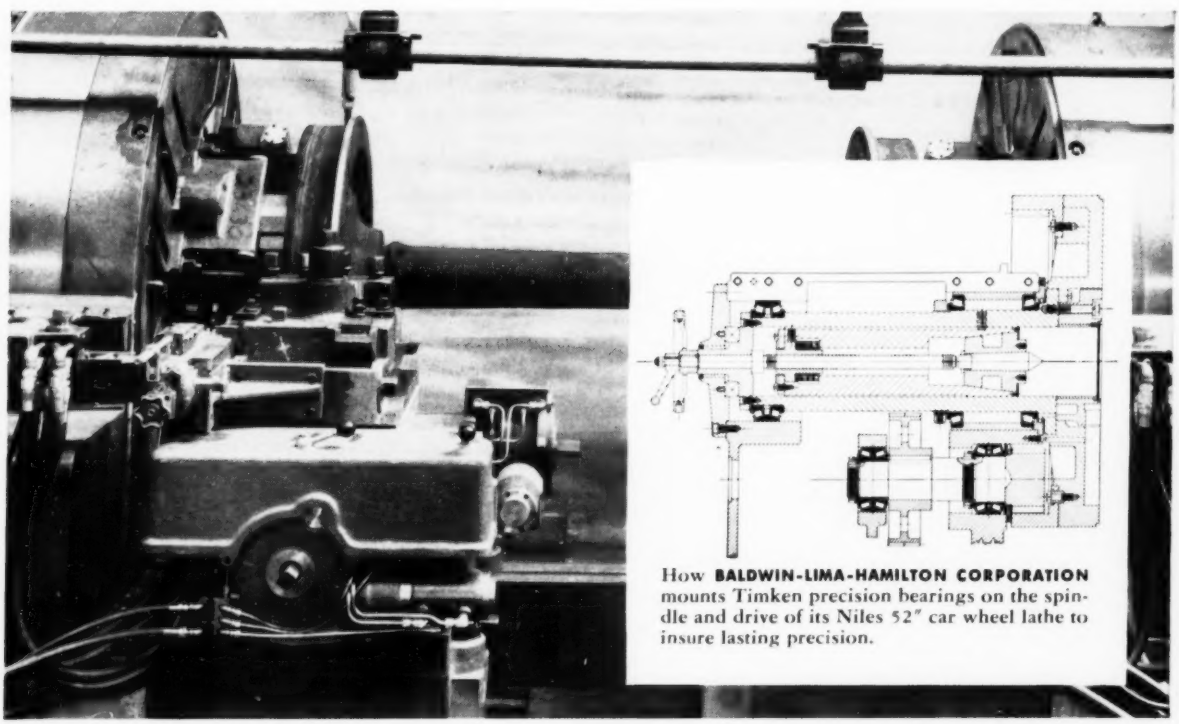
To maintain the high precision necessary, Niles mounts the lathe spindle on Timken* tapered roller bearings. Because of line contact between their rollers and races, Timken precision bearings have extra load-carrying capacity. Their tapered construction takes both radial and thrust loads, permits pre-loading to any desired degree. Result: deflection is minimized, long-lasting accuracy is assured.

To help turn the heavy load of the wheels and axles smoothly, Timken bearings are also used in the drive. They hold shafts in alignment, insuring accurate gear mesh, longer gear life.

Timken bearings are easy and less costly to assemble. Manufacturing costs are reduced. Auxiliary thrust bearings are eliminated, maintenance is simplified.

No other bearing can give you all the advantages of Timken bearings. Make sure you have them in the machine tools you build or buy. Always look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN BEARING EQUIPPED — *This symbol on a product means its bearings are the best.*



How **BALDWIN-LIMA-HAMILTON CORPORATION** mounts Timken precision bearings on the spindle and drive of its Niles 52″ car wheel lathe to insure lasting precision.

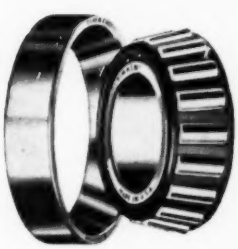
MAGNIFYING GLASS INSPECTION OF EVERY ROLLER!

Every one of the over one billion Timken bearing rollers produced every year is inspected with powerful magnifying glasses to detect surface flaws. It's just one example of how the Timken Company insures uniform high quality.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ↓ AND THRUST →▯← LOADS OR ANY COMBINATION →▯←